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Ontario

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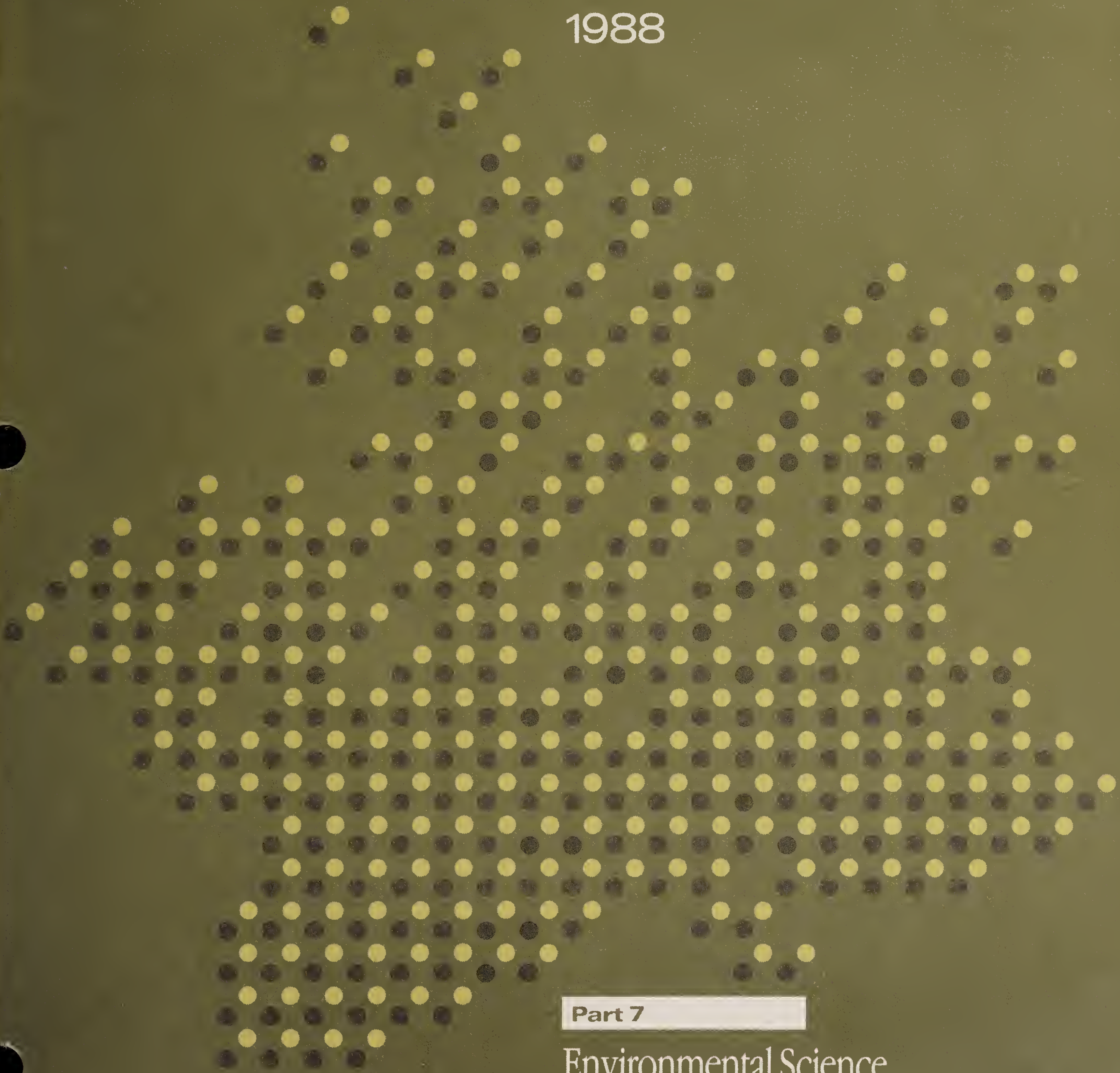
Curriculum Guideline

Science

Intermediate and Senior Divisions

1988



Part 7

Environmental Science

Grades 10 to 12, General Level

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Introduction

The Parts of the Guideline

This document is Part 7 of a fifteen-part curriculum guideline that outlines the science program for the Intermediate and Senior Divisions in Ontario schools and describes the science courses that can be offered (see the list of courses and their course codes in Appendix A). The term *guideline* refers to the entire set of fifteen parts.

This part must be read and implemented in conjunction with Part 1, *Program Outline and Policy*. When implementing the courses that are described in this document, teachers are to incorporate the many policies and features outlined in Part 1, which will enable them to interpret the overall intent and expectations of the Ministry of Education in the science program. The table of contents for Part 1 is given in Appendix B at the end of this document so that the reader may have ready access to the list of chapters and topics therein.

The provincial science program for the Intermediate and Senior Divisions comprises the courses described in Parts 2 to 15. These come under the framework and policy set forth in Part 1. The entire science guideline consists of the following fifteen parts:

Part 1: Program Outline and Policy
Part 2: Science, Grades 7 and 8
Part 3: Science, Grades 9 and 10, General Level
Part 4: Science, Grades 9 and 10, Advanced Level
Part 5: Science, Grades 9 and 10, Basic Level
Part 6: Science, Grades 11 and 12, Basic Level
Part 7: Environmental Science, Grades 10 to 12, General Level
Part 8: Environmental Science, Grades 10 and 12, Advanced Level
Part 9: Applied Biology and Applied Chemistry, Grade 11, General Level
Part 10: Applied Physics and Technological Science, Grade 12, General Level
Part 11: Geology, Grade 12, General and Advanced Levels
Part 12: Biology, Grade 11, Advanced Level, and the OAC
Part 13: Chemistry, Grade 11, Advanced Level, and the OAC
Part 14: Physics, Grade 12, Advanced Level, and the OAC
Part 15: Science in Society, OAC

The chart on the next page indicates the twenty-eight science guideline courses that may be offered in Grades 7 to 12 and at the OAC level.

Policies and Features That Apply Across the Science Program

Part 1 of the guideline specifies a great number of the policies and features that are to be integrated into the design of the science program in the Intermediate and Senior Divisions. There are too many of them to describe in full in each of Parts 2 to 15, but the following points will give the reader some idea of the scope that is involved. They include:

- information about the science credits that are required for the earning of the Ontario Secondary School Diploma;
- a list of science courses that are prerequisite to other science courses;
- the policy regarding mandatory student activities in the science laboratory;
- a list of the aims of the science curriculum and the various emphases that may be used to blend these aims with scientific content;
- policy governing time allocations for units of study and the order in which core and optional units may be taught;
- stipulations about locally designed units;
- suggestions about preferred routes that students might take through the science program in a secondary school;
- recommendations related to exceptional students, individualized instruction, life-management skills, career awareness, the role and evaluation of language in science courses, and a balanced perspective on the role of both girls and boys in science;
- recommendations on the introduction and handling of sensitive issues;
- specific suggestions about resources for the teaching of science;
- ideas about different modes of delivering science courses, including the co-operative education mode;

Authorized Science Guideline Courses, Intermediate and Senior Divisions

	Basic Level	General Level	Advanced Level
Grade 7	Science		
Grade 8	Science		
Grade 9	Science (SNC1B)	Science (SNC1G)	Science (SNC1A)
Grade 10	Science (SNC2B)	Science (SNC2G)	Science (SNC2A)
		Environmental Science (SEN2G)	Environmental Science (SEN2A)
Grade 11	Science (SNC3B)	Applied Biology (SBA3G)	Biology (SBI3A)
		Applied Chemistry (SCA3G)	Chemistry (SCH3A)
		Environmental Science (SEN3G)	
Grade 12	Science (SNC4B)	Environmental Science (SEN4G)	Environmental Science (SEN4A)
		Geology (SGE4G)	Geology (SGE4A)*
		Applied Physics (SPA4G)	Physics (SPH4A)
		Technological Science (STE4G)	
OACs			Biology (SBI0A) *Prerequisite* – Biology (SBI3A)
			Chemistry (SCH0A) *Prerequisite* – Chemistry (SCH3A)
			Physics (SPH0A) *Prerequisite* – Physics (SPH4A)
			Science in Society (SSO0A) *Prerequisite – One of:* Biology (SBI3A) Chemistry (SCH3A) Environmental Science (SEN4A) Geology (SGE4A)* Physics (SPH4A)

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*Since the Grade 12 advanced-level geology course described in the guideline (see Part 11) may be taught under the aegis of a geography department as Geology (GGE4A) – note the course-code change – then either Geology (SGE4A) or Geology (GGE4A) may count as a prerequisite to Science in Society (SSO0A).

- policy pertaining to the significant role to be played by measurement and metric units in science courses;
- stipulations related to the treatment of symbols, significant digits, and mathematical problem solving;
- recommendations concerning the roles to be played by calculators and computers in science courses;
- specific directions about safety;
- policy and principles pertaining to the evaluation of student achievement;
- policy regarding differences in the treatment of science courses at the three levels of difficulty;
- many suggestions about implementing the science program.

It cannot be emphasized strongly enough that teachers of science must integrate the policy and recommendations outlined in Part 1 with the teaching of science and cannot simply rely on the course descriptions given in Parts 2 to 15 of the guideline.

The Science Curriculum Continuum

By the time students have reached the Senior Division, they will have experienced first a *unified* approach in the Primary and Junior Divisions, in which science is related to a number of other subject areas, and then a *diversified* approach to a mosaic of science disciplines – biology, chemistry, physics, and environmental science – in the Intermediate Division. In the Senior Division they are provided with a *specialized* approach, in which the science courses deal with a single discipline at a time.

Although these approaches – unified, diversified, and specialized – provide different ways of dealing with the subject, the intention is to ensure that there is a continuum throughout the years. For instance, the Grade 10 environmental science course outlined in this document is an extension of the science courses offered in Grades 7 to 9, particularly of those units of study dealing with the life and environmental sciences. Similarly, the Senior Division courses in environmental science build on the Grade 10 environmental science course described in this document.

Teachers of environmental science should be aware of the subject matter contained in other science courses so that their courses can be planned to complement the other courses.

In all environmental science courses the core units and the prescribed number of optional units, if any, are to be included. The time allocation for each unit of study should act as a guide in helping teachers devote an appropriate amount of time to each of the units in a course and thus ensure a balanced program.

Compulsory and Prerequisite Courses

In the secondary school program, two science courses are required among the compulsory subjects that are necessary for the earning of the Ontario Secondary School Diploma. It is recommended that students first take a Grade 9 science course, followed by a Grade 10 science or environmental science course, in order to obtain at least two science credits towards the diploma, before proceeding to take Senior Division science courses as desired.

In the secondary school program a number of options are possible, and principals and teachers should advise students of such options. (See OSIS, subsection 4.10, notes (d) and (e), as well as Part 1 of this science guideline, subsections 4.3 and 4.5.)

Curriculum Emphases

It is recommended that teachers organize each of the courses described in this document around a particular curriculum emphasis or set of emphases. Such emphases give the curriculum a special focus that can be introduced in addition to the content and processes outlined in the courses. This approach is discussed in subsection 3.4, "Curriculum Emphases – Blending Curriculum Aims With Content", of Part 1 of the science guideline. A list of emphases is given in table 2 in that subsection. These emphases will enhance the development of the science courses described in this document. A particular emphasis that is stressed throughout an entire course or for one or more units at a time needs to be highlighted so that it becomes a focal or integrating theme.

Student Activities

In each unit of study there is a section entitled "Student Activities". This section indicates the mandatory laboratory activities required of students. Teachers may substitute equivalent laboratory activities where appropriate. Those activities that are actually to be performed by students themselves are marked with asterisks. If time and circumstances permit, the teacher should encourage students to do some or all of the unmarked activities as well. However, such activities may be demonstrated by a student or the teacher or may be discussed in conjunction with a textbook, film, computer program, or other learning material used as a resource. In any event, the scientific concepts and principles related to such unmarked activities and identified in the objectives of the unit of study shall be considered to be part of the prescribed course.

Generally, the best approach to the teaching of science is to ensure that the content develops directly from related student activities. In each unit of study the skills and processes of scientific work should be presented as the central component, from which the subject matter, applications, and implications emerge.

Safety

Safety awareness must be developed in all science students. Constant attention to accident prevention is to be stressed in all student activities and teacher demonstrations in the laboratory. Section 9, "Safety", in Part 1 of the science guideline contains the following comprehensive subsections:

- Safety in the Laboratory
- Some Recommended Safety Procedures
- Animal Care in Science Courses
- The Safe Use of Plants

In each unit of study, subsection 6, "Safety Considerations", acts as a reminder of some of the safety features that pertain to the unit in question. General reference, however, should constantly be made to the safety section in Part 1. Schools must always remain on the alert in regard to safety and maintain an up-to-date safety-awareness program.

Sensitive Issues

The curriculum outlined in this science guideline places a distinct emphasis on the science-technology-society connection. For this reason scientific applications and societal implications are mandatory components of each unit of study. In addition, Part 1 of the guideline underlines the need to incorporate morals/values education into science courses. Undoubtedly, this will give rise to the discussion of some sensitive issues.

Such discussions are important. Generally, they should be focused and should provide an open forum for the expression of different viewpoints. In this regard teachers of science are urged to familiarize themselves with section 10, "Values in Science Education", of Part 1 of the guideline and to pay particular attention to the principles to be observed when dealing with sensitive issues in the science curriculum. These principles are mentioned in subsection 10.2 of Part 1.

Locally Designed Units

Among the optional units in each of the courses described in this guideline is one entitled "Locally Designed Unit". Such a unit is included to allow teachers, at their discretion, to introduce an appropriate new area of environmental science not described in the guideline, to include additional new work that will expand on previous topics in the course, or to extend the time allocations for the core units. If new topics are introduced in a locally designed unit, care should be taken to avoid topics that are included in the remaining general-level environmental science courses unless students are unlikely to take these courses. Two locally designed units are included in the Grade 12 course to provide teachers with additional opportunities to design a course that meets specific local needs.

Evaluation of Student Achievement

In each unit of study described in the courses outlined in this document, section 5, "Evaluation of Student Achievement", specifies certain items that must be included in the students' term marks (exclusive of formal examinations) when their achievement is evaluated. In most units teachers are required to evaluate students' activities and related laboratory reports. However, the proportion of the mark assigned will vary from one teacher to another. In order that the experimental component of science be emphasized, the overall mark for an entire science course must include at least 15 per cent for the evaluation of student achievement in laboratory skills and reports.

Cross References

In the descriptions of each unit of study in the courses outlined in this document, cross references are provided in parentheses. These are included to illustrate some examples of the relationships among the parts of the unit.

Particular Features of the General-Level Environmental Science Courses

Units of Study and Their Time Allocations

The following chart provides an overview of the units of study in the Grade 10 to 12 environmental science courses at the general level. They also indicate the time to be allocated to each unit.

Environmental Science, Grade 10, General Level (SEN2G)

Units of Study		Time Allocations
Core		
1. Plant Science I		15 h
2. Animal Adaptations		15 h
3. Soil Science		15 h
4. Energy: Interaction and Dependence		20 h
5. Ecosystems		15 h
		80 h
Optional		
Two of:		
1. Horticulture I	15 h	30 h
2. Forestry I	15 h	
3. Basic Gardening	15 h	
4. Living With Insects	15 h	
5. Agricultural Crop Science I	15 h	
6. Locally Designed Unit	15 h	
		110 h

Environmental Science, Grade 11, General Level (SEN3G)

Units of Study		Time Allocations
Core		
1. Energy Pathways		16 h
2. Plant Science II		16 h
3a. Animal Science *or* 3b. Wildlife Biology		16 h
4. Aquatic Ecosystems		17 h
		65 h
Optional		
Three of:		
1. Horticulture II	15 h	45 h
2. Forestry II	15 h	
3. Agricultural Crop Science II	15 h	
4. Landscaping I	15 h	
5. Garden Maintenance	15 h	
6. Noise Pollution	15 h	
7. Outdoor Skills	15 h	
8. Locally Designed Unit	15 h	
		110 h

Environmental Science, Grade 12, General Level (SEN4G)

Units of Study		Time Allocations
Core		
1. Soils: An Important Resource		15 h
2. Air Quality and Waste Management		20 h
3. Pests and Pest Control		15 h
		50 h
Optional		
Four of:		
1. Horticulture III	15 h	60 h
2. Comparative Ecosystems	15 h	
3. Plant and Animal Pathology	15 h	
4. Applied Genetics	15 h	
5. Landscaping II	15 h	
6. Agribusiness	15 h	
7. Locally Designed Unit	15 h	
8. Locally Designed Unit	15 h	
		110 h

Some Suggestions for Teaching and Evaluation

These courses are designed to introduce students to the many diverse topics that make up a study of environmental science. The selection of appropriate optional units will permit teachers to design courses that focus on local interests, needs, and resources.

Schools may offer one, two, or three general-level environmental science courses. The core units and the required number of optional units must be completed according to the particular course(s) offered. The optional units for any course may be selected from the core and optional units of a general-level environmental science course at another grade level that is not provided in the school.

Consistent with the nature of all science courses, the laboratory and field activities should be the focus of each of the units studied.

The topics in these courses tend to be more interdisciplinary than those normally found in a traditional science course. The activities are relevant and applied, while theoretical considerations play a less dominant role. For this reason teachers of environmental science should communicate with teachers of other departments when planning these courses so that the various related courses are seen to be complementary.

The interrelationship between science and society is important in environmental science courses. The applications and societal implications of each unit are therefore important features of these courses.

It is intended that the overall evaluation of student achievement reflect the primary emphasis on practical laboratory and field work and include other components as required.

Environmental Science, Grade 10, General Level
(SEN2G)

Core Units

Plant Science I
Animal Adaptations
Soil Science
Energy: Interaction and Dependence
Ecosystems

(80 hours)

Optional Units

Horticulture I
Forestry I
Basic Gardening
Living With Insects
Agricultural Crop Science I
Locally Designed Unit

(30 hours)

Core Unit 1

Plant Science I

Time: 15 hours

An understanding of the structure of seeds and roots is very useful in making decisions about germination and seedling growth. A knowledge of the environmental factors affecting these processes is essential in studies of ecology, gardening, crop science, and forestry. This unit will help students understand the importance of plants to people and to the survival of all animal life.

This unit may be divided into topics such as the following:

- Plant diversity
- The seed
- The germination of seeds
- Roots
- Factors affecting the growth of seedlings
- The importance of plants

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the complexity of plant structure and growth (2a, 2b);
b) an objectivity in interpreting the data from experiments (2b);
c) a respect for the value of scientific instruments such as the microscope (2e);
d) a curiosity about finding answers to questions through experimentation (2b).

Skills. Students will have opportunities to develop skill in:

a) designing and carrying out experiments to investigate plant growth (2b);
b) using a microscope to examine root cross sections (2e);
c) drawing graphs of root growth (2g);
d) germinating seeds in various conditions (2h).

Knowledge. Students will be expected to:

a) name the parts of a seed (2a);
b) describe the factors that affect seed germination (2h);
c) describe the characteristics of different seeds (2c);
d) outline the structure and function of root hairs (2f);
e) describe the soil conditions that are required for plant growth (2b);
f) explain the effect of crowding on plant growth (2h);
g) explain why only a few of the many seeds produced germinate in a natural setting (2i);
h) explain the role of plants in a food chain;
i) explain briefly the importance of plants in natural ecosystems and in agriculture.

2. Student Activities

Students are to:

a) dissect and describe the parts of a seed (6b, 8a, 8d);
*b) design and carry out an experiment to determine the effect of various environmental conditions on germination (e.g., freezing, heat, moisture, storage time, soil compaction, soil temperature);
c) collect a variety of seeds on a fall field trip and compare their characteristics;
d) observe the evidence of herbivore activity in a natural setting or garden (e.g., that of a mouse, porcupine, or a beaver);
e) investigate the effect of dry air on root hairs;
f) measure and graph the growth of roots from germinating seeds over several days;
*g) germinate many seeds in one pot to demonstrate the competition for nutrients caused by crowding;
h) investigate the proportion of seeds that germinate in a natural area.

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) During transplanting roots must be prevented from drying out.
b) Most types of seeds have optimum germination temperatures. As a result, lettuce and lawn grass grow better in the spring and early fall than in the hot summer months.
c) There is an optimum number of seeds that can be planted in a given planting area in order to obtain the best growth.
d) The holes in flower pots help control drainage.

4. Societal Implications

a) A variety of environments must be maintained in order to provide habitats for a wide variety of plants.
b) People depend on healthy plant populations for food, fibres, fuel, and structural materials.
c) Careful assessment should be done before widespread environmental changes are made (e.g., tropical forests are cut, farmlands are used for urban housing).

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory and field work;
b) ability to design experiments;
c) ability to use the microscope.

6. Safety Considerations

a) Students should be asked to report any allergies to plant materials to the teacher.
b) Students should be cautioned to use care when using sharp blades to cut plant material.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) do a comparison study of the germination rates of various seeds;
b) make a closed terrarium containing plants and invertebrates;
c) design and carry out experiments to determine whether plant pots should have drainage holes;
d) discuss the number of seeds produced in a given ecosystem in comparison with the number that will eventually produce adult plants;
e) visit a greenhouse or nursery to discuss the commercial growing of plants from seeds.

8. Some Teaching Suggestions

a) A variety of seeds should be provided by the teacher or collected by the class on a fall trip. Examples can include seeds from a flower garden (e.g., zinnia, marigold, snapdragon), a vacant lot (e.g., mustard, grass, hawthorn), a feed store (e.g., wild birdseed, wheat, corn), or a forest (e.g., beech, maple, oak).
b) This unit can be integrated with other units of the course that relate to plants (e.g., units on ecosystems and soils). This approach allows a longer period of time for the plants being studied to grow and develop.
c) If access to sunlight is a problem, students can grow and make their observations on plants at home. Alternatively, banks of fluorescent tubes can be set up in the classroom.
d) A detailed coverage of seed and root structure is not appropriate in this unit.

Core Unit 2

Animal Adaptations

Time: 15 hours

The survival of both wild and domestic animals depends on their ability to maintain a balanced internal environment among their body systems. Also, if a species is to survive, it must produce enough offspring to ensure a stable population over the years. A species that is not adapted to its environment will not survive. In this unit students will have the opportunity to examine the various ways in which animals are adapted to their environment.

This unit may be divided into topics such as the following:

- Mammalian systems
- The internal environment of an organism
- The external environment of an organism
- Adaptations for survival

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a curiosity about the ways in which organisms are adapted to their environment (2e);
b) an appreciation for the struggle for survival of all animal species (3b, 4c);
c) a concern for the survival of animal species when harmful changes in the environment are caused by human action (4c);
d) a curiosity about the reasons why some animals are endangered (3c, 4d).

Skills. Students will have the opportunity to develop skill in:

a) following procedures to set up animal cultures (2b);
b) designing experiments to test the reaction of animals to environmental stimuli (2c);
c) inferring the relationship between the number of offspring produced by an animal and the amount of care given by the parents (2d);
d) inferring the type of food eaten by an insect after examining the insect's mouthparts (2f);
e) recording information regarding the adaptations of several wild birds and wild mammals (2g).

Knowledge. Students will be expected to:

a) recall the names and general functions of mammalian systems, such as digestion, gas exchange, excretion, circulation, co-ordination, and reproduction (2a);
b) describe the importance of all of the systems working together to maintain the internal environment of an organism (2a);
c) outline why an animal must be able to react to its external environment (2c);
d) compare the number of offspring produced by simple and more complex animals (2d);
e) relate parental care of offspring to the number of offspring produced by parents in some simple and more complex animals (2d);
f) compare aspects such as means of locomotion, selection of habitat, body covering, and protective colouration as methods of adaptation for survival for various animals (2e-2g);
g) identify methods of survival for at least two commercially important insects (2f);
h) outline adaptations for survival of at least one wild bird and one wild mammal (2g);
i) select one Canadian endangered species and state reasons for its endangered status (2h).

2. Student Activities

Students are to:

a) examine diagrams of the systems of such animal groups as amphibians, birds, and mammals and make a table showing the general function of each system (8a, 8b);
*b) prepare cultures to examine the life cycles of such organisms as sow bugs, earthworms, or mealworms (8c);
*c) design simple experiments to observe the reactions of cultured organisms to environmental stimuli such as wet and dry surfaces and light and dark areas;
*d) gather and tabulate information regarding the number of offspring produced and the kind and amount of parental care provided for at least five animals;
e) examine a variety of live and preserved animals, using photographs if necessary, and construct a table indicating the main characteristics of each species. The following are examples of headings that could be used: Habitat, Body covering, Types of appendages, Methods of locomotion, Defences, Sense organs, Colouration and other adaptations (6a);

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*See the subsection entitled "Student Activities" on page 5.

*f) examine live or preserved insects, noting adaptations that have allowed the insects to survive and in particular how the mouthparts are adapted to the type of food eaten (6a);
g) observe drawings or photographs of birds and mammals and outline adaptations that have helped them survive;
h) illustrate the life cycle of one Canadian endangered or threatened animal species and indicate where in the life cycle the main threat to the species occurs (e.g., egg production in peregrine falcons).

3. Applications

a) A knowledge of how animals compete for survival provides the basis for developing methods to protect animal life.
b) Dramatic changes in the environment of an animal may lead to its extinction.

4. Societal Implications

a) Careers such as animal breeder, animal-care technician, zoo keeper, and wildlife biologist require a knowledge of animals.
b) Interference with the balance of nature can cause the population number of a species to multiply excessively or diminish drastically.
c) Wild animals are often not considered when residential or industrial development occurs. When a species' natural habitat is altered or destroyed, the animals may not survive or may become pests to humans.
d) Each species of animal has a role to play in the environment. If one species becomes extinct, all other species, including humans, will be affected.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) records of information from student activities;
b) ability to design experiments to test the reaction of animals to external stimuli;
c) ability to interpret data from experiments.

6. Safety Considerations

a) Students must wash their hands after handling live or preserved animals in the laboratory.
b) Wild vertebrates must not be brought into the classroom.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) visit a zoo, an agricultural fair or exhibition, or an outdoor field centre to do in-depth studies of various animals;
b) invite a veterinarian or wildlife biologist to visit the school to talk about his/her work with animals;
c) gather information from various sources regarding endangered or threatened animal species;
d) compare the anatomy of various systems in invertebrate or vertebrate animals;
e) design methods that could be used to determine the population of an animal species in the local area;
f) evaluate the functions of zoos and animal sanctuaries in maintaining animal populations;
g) investigate the work of the local animal-control agency to discover what problems it encounters and what its employees do.

8. Some Teaching Suggestions

a) Students may not be familiar with the names of the various animal systems. Simple diagrams or charts of the systems should be used as the functions of the systems are discussed. Students should not be required to memorize the anatomy of each animal system.
b) Simple flow charts should be used to illustrate how the functioning of one system depends on the functioning of another system.
c) Cultures of earthworms and sow or pill bugs may be kept in shallow loam soil (10-20 cm) covered with a good layer of leaf or other plant litter. The soil and litter should not be allowed to dry out nor should it be saturated with water. These animals may be kept all year in this culture.
d) Live animals should be used in this unit, if possible. The need to provide humane care for all living things should be emphasized in this unit.
e) Student-oriented, hands-on activities should be emphasized whenever possible. A variety of written materials from various texts as well as from conservation groups, governments, private business, and industry can add interest to the unit.
f) Guest speakers, such as biologists, ornithologists, or veterinarians, can add a great deal of interest to the unit.
g) Students can visit a farm to see how the needs of various domestic species are met.

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*See the subsection entitled "Student Activities" on page 5.

Core Unit 3

Soil Science

Time: 15 hours

This unit considers the origin and composition of soil and its importance to plant and animal life. It provides students with knowledge that will be of value to them in growing indoor plants, gardening, or pursuing careers in horticulture or agriculture.

This unit may be divided into topics such as the following:

- Composition of soil
- Physical properties of soil
- Classification of soil according to texture
- Life in the soil

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that soil is an essential part of the food production system (3a, 3b);
b) a curiosity about the organisms that live in soil (2f);
c) a concern for soil as a limited resource that must be managed wisely (4b).

Skills. Students will have the opportunity to develop skill in:

a) observing the effects of weathering (2b);
b) measuring physical properties of soil (2c);
c) using laboratory apparatus to determine the components of soil (2c, 2d);
d) observing and identifying types of soils, soil organisms, and soil components, such as sand, silt, clay, and gravel (2d, 2f);
e) using soil separators to determine soil texture (2d).

Knowledge. Students will be expected to:

a) explain the importance of soil to plant growth (2a);
b) describe processes of soil formation, such as weathering and leaching (2b);
c) describe some physical properties of soil, such as texture, colour, particle size, percolation rate, pore space, water content, and water-holding capacity (2c-2e);
d) identify and describe the roles of some soil organisms (2f);
e) describe the composition of good agricultural soils for such crops as potatoes, corn, and soybeans;
f) describe the processes involved in maintaining and building topsoil;
g) describe methods of restoring soil nutrients (2g);
h) explain some methods of soil conservation (2h);
i) identify the ways in which water is held in the soil (e.g., capillary, hygroscopic, gravitational).

2. Student Activities

Students are to:

a) compare the growth of seeds such as beans in various media (8c);
*b) examine the effect of hydrochloric acid on limestone or the effect of alternations of extreme heat and cold on rock samples (6a);
*c) analyse soil for organic matter, water content, water-holding capacity, and minerals (8b, 8e);
*d) measure the per cent of sand, silt, and clay separates in soil to determine the soil type from a soil triangle (8e);
e) determine the percolation rate of the soil at one or more nearby locations (8b);
f) investigate the organisms found in a soil sample and explain the function of selected organisms (8d, 8f);
g) identify the nutrients on the label of a chemical fertilizer and, on the basis of the instructions, determine how much should be used in a specified area;
h) describe and, if possible, photograph local examples of soil erosion and conservation methods.

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) The type of soil is one of the factors that determine which crops can be grown in a particular area.
b) An understanding of the properties of soil enables gardeners and farmers to improve plant growth (e.g., by adding sand to clay soils).
c) A knowledge of soil percolation rates can be used in designing a septic bed or a field-drainage system.
d) A knowledge of the soil texture enables a gardener or a farmer to decide on proper tillage and irrigation practices.
e) A knowledge of soil types and properties is helpful in developing conservation projects and in choosing sanitary landfill sites and hazardous-waste disposal sites.

4. Societal Implications

a) The overuse or misuse of soil that is suitable for agriculture may lead to food shortages and increased food prices.
b) In southern Ontario, the land most suited to farm crops is also most suited for housing and commercial development.
c) Loss of soil through erosion is a problem in Ontario.
d) Many careers make use of a knowledge of soils (e.g., soil technician, farmer, nursery manager).
e) Much of the high nutrient pollution of lakes and streams results from improper fertilizing, tillage, and crop selection.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) ability to use laboratory equipment;
b) laboratory reports, notes, projects, and assignments.

6. Safety Considerations

a) Students should wear appropriate eye protection when heating rock samples or using acids.
b) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) identify additional soil organisms and explain their roles in the soil;
b) outline soil-conservation practices used in the local community;
c) analyse a soil sample from a home garden or field.

8. Some Teaching Suggestions

a) The importance of soil and an appreciation of the importance of using soil properly should be emphasized throughout the unit.
b) The properties of local soils, such as those from a well-cultivated garden or field, a trampled area, an undisturbed area, and a damp area, can be compared.
c) The rates of growth of a plant species in various media can be compared.
d) Students can attempt to identify the organisms found in a soil sample by using a field guide or simple key.
e) Soil samples should be collected before the ground freezes. These samples can be stored in moisture-proof containers in a cool place.
f) Soil samples rich in living organisms should be provided for students to examine.

Core Unit 4

Energy: Interaction and Dependence

Time: 20 hours

All life depends for its existence on many different forms of energy. The excessive use of non-renewable energy sources has caused shortages on a global scale. In the future, alternative renewable sources of energy will become more important. These forms will require careful development, with consideration given to the consequences of their use.

This unit may be divided into topics such as the following:

- Renewable and non-renewable sources of energy
- Conservation of energy

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that non-renewable sources of energy must be conserved (4b);
b) a commitment to use renewable sources of energy where possible (3a, 4a);
c) an appreciation of the benefits of developing alternative energy sources (3d, 3e);
d) objectivity in deciding which sources of energy will be most important in the future for Ontario (4c);
e) an appreciation that our current lifestyle is dependent on abundant energy (4).

Skills. Students will have the opportunity to develop skill in:

a) observing and recording various energy-saving components in new or old building construction (2c, 2d);
b) designing and carrying out experiments (2d);
c) designing and building a device such as a solar collector or a wind generator that will use alternative sources of energy (2f);
d) debating or discussing alternative energy sources for Ontario (2e);
e) determining the percentage composition by mass of the components of a TV dinner (2g);
f) estimating the energy used in preparing the components of a TV dinner (including making the tray) or in taking a long-distance trip (2g).

Knowledge. Students will be expected to:

a) give examples of different forms of energy (2b);
b) explain how energy can be converted into usable forms, for example, the conversion of the energy in falling water to electrical energy (2a);
c) classify various sources of energy as renewable or non-renewable (2e, 2f);
d) describe the value of analysing energy usage from a systems point of view (2b, 2g, 8b, 8c);
e) list alternative forms of energy and evaluate them for their practicality, effect on the environment, and their ability to be stored (2e, 2f);
f) explain the importance of insulating materials (2c, 2d);
g) explain the importance of energy conservation to the availability of energy resources in the future (2e);
h) explain some possible effects of reduced energy consumption on lifestyles (2f, 2g);
i) compare the energy consumption and environmental impact of leisure activities such as cross-country skiing and snowmobiling, sailing and power boating, and watching a game on TV and participating in a sport;
j) describe ways of conserving energy in housing, transportation, food processing and packaging, and recreation (2f, 2g);
k) identify some of the unique problems related to energy consumption in Canada (e.g., long-distance travel).

2. Student Activities

Students are to:

a) burn a nut (e.g., a brazil nut or peanut) and use the heat energy to do useful work (e.g., to distil a coloured solution or boil water);
b) observe and describe several energy transformations (e.g., in a flashlight, a solar motor, an automobile engine, or a hydroelectric generator;
c) visit the site of a building under construction and determine what energy-saving components are being built into the structure;
*d) design and carry out experiments to test the insulating value of various materials;

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*See the subsection entitled "Student Activities" on page 5.

e) collect pertinent data on possible alternative energy sources available to Ontario and debate or discuss which forms should be developed;
*f) design and build a device that will utilize an alternative energy source to do useful work (e.g., a solar collector to cook food) (6a);
*g) estimate the total amount of energy used in preparing a meal (e.g., a TV dinner) or in taking a long-distance trip (8e).

3. Applications

a) Solar collectors are being used to heat water (e.g., swimming pools).
b) Energy-efficient heating and cooling systems are being installed in various kinds of buildings.
c) Individuals can choose alternative lifestyles that can reduce fuel-energy consumption (e.g., sailing instead of motorboating, biking or walking instead of driving).
d) Motorists can save money by driving energy-efficient cars and developing energy-efficient driving habits.
e) An understanding of energy conservation makes it possible to save money in the home.

4. Societal Implications

a) The use of solar collectors and other alternative energy sources can protect the dwindling reserves of fossil fuels.
b) If fossil-fuel energy becomes increasingly more difficult to obtain, people will be forced to change their way of life.
c) The federal and provincial governments establish energy policies that attempt to make the best use of our energy resources.
d) One way to prevent a future energy crisis may be to spend money now on research into and development of alternative energy sources.
e) The use of public transportation (e.g., buses and trains) rather than private cars can save money and energy as well as reducing air pollution.
f) The burning of fossil fuels to provide energy for transportation and industry can cause acid deposition, air pollution, changes in climate, and other undesirable side effects.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work and laboratory reports;
b) assignments and notes developed in class;
c) ability to design simple experiments.

6. Safety Considerations

a) Students should be cautioned that solar devices can produce high temperatures.
b) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) survey the community to determine attitudes towards energy conservation;
b) plan and carry out a drive to conserve energy within the school.

8. Some Teaching Suggestions

a) It should be stressed throughout the unit that all forms of energy tend to end up eventually as heat, which is subsequently lost through radiation to outer space.
b) Students can examine one or more systems, such as a school, a house, an apartment, an automobile, or a farm, listing and discussing its energy inputs and outputs. They should identify the part of the input energy of the system that is renewable and the part that is non-renewable and discuss the finite nature of non-renewable resources and the probable need to reduce inputs or find alternatives. They should also discuss the advantages and disadvantages of using the various forms of energy identified.
c) Students can describe ways of reducing the energy input to a system by conservation practices. They might consider the automotive system (e.g., driving habits), home system (e.g., insulators), and farm system (e.g., cultivation practices). In dealing with farm cultivation practices, students should look at aspects such as fuel use, the types and quantity of fertilizer used, and crop rotation.
d) In order to carry out some of these experiments, students may have to work in groups.
e) In activity 2g all the energy consumed in developing the meal – in the production of the aluminum tray, farm production, and the cooking, freezing, shipping and handling, and reheating of foods in the home – should be considered. Similarly if a long-distance trip is considered, the fuel consumption and the energy used in the manufacture of the vehicle and in road maintenance should all be considered.

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*See the subsection entitled "Student Activities" on page 5.

Core Unit 5

Ecosystems

Time: 15 hours

The intent of this unit is to review and reinforce students' knowledge of ecological principles and terminology through the study of a local ecosystem. Students should discover that the ecological principles at work in a small ecosystem also operate in a large biome such as the Canadian tundra.

This unit may be divided into topics such as the following:

- Components of an ecosystem
- Biotic factors in an ecosystem
- Abiotic factors in an ecosystem
- Interactions in an ecosystem
- A Canadian biome

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the delicate balances in an ecosystem (3a, 4a, 4c);
b) a concern for the protection of the environment (3b, 3d);
c) a respect for living things and a commitment to care for them humanely and responsibly (3d).

Skills. Students will have the opportunity to develop skill in:

a) observing and describing the components of an ecosystem (2a-2c);
b) measuring abiotic characteristics in an ecosystem, for example, wind speed, soil temperature, relative humidity, nutrients, light intensity, and pH (2a-2c);
c) reading a thermometer, measuring wind speed, and testing soil for nutrients and pH (2c, 2d, 2g).

Knowledge. Students will be expected to:

a) define basic ecological terms such as the following: population, community, producer, consumer, decomposer;
b) list the main components of an ecosystem (2a-2c);
c) list and describe biotic and abiotic factors in an ecosystem;
d) compare natural ecosystems with a managed ecosystem (2g);
e) describe the principal climatic and biological characteristics of at least one major Canadian biome (2f);
f) explain the interactions between the biotic and abiotic factors of an ecosystem, for example, food chain, food web, food pyramids, and nutrients cycle (2a, 2b).

2. Student Activities

Students are to:

*a) observe and record the biotic and abiotic components of an ecosystem, such as a grassy field (6, 8b, 8e);
b) make observations or comparisons of two ecosystems, such as a grassy field and a woodlot (6, 8b, 8c, 8e);
*c) using several miniature ecosystems, design and carry out experiments to show the long-term effects on the ecosystem of changing some of the following: temperature, light intensity, amount of mineral nutrients, number of producers, number of consumers (8g);
d) design and carry out experiments to show the effect of crowding on the growth of plants;
e) use an anemometer to measure the effect of plants in an ecosystem on the strength of the wind at various levels (8d);
f) compare a local ecosystem with a major Canadian biome to show their similarities and differences (8f);
g) debate which is more efficient in producing biomass – an agricultural crop or a natural ecosystem;
h) design and carry out an experiment to show the effects of different light intensities on the growth pattern of a plant (e.g., impatiens).

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) A knowledge of the effects of abiotic factors on plants can be used to improve crop production.
b) The creation of wildlife sanctuaries, conservation areas, and successful farms requires an understanding of ecological principles.
c) Pollutants in ecosystems can be detected and their effects foreseen.
d) A suitable environment can be provided for pets, wildlife, and livestock.

4. Societal Implications

a) Human activities often alter the natural balance in an ecosystem, causing some species to become extinct and others to multiply too rapidly.
b) Disagreement about the sensitivity and value of an ecosystem can lead to political controversy.
c) Logging and the construction of roads and dams can interfere with natural succession.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) field observations, collection and interpretation of data, assignments, and projects;
b) ability to design and carry out experiments.

6. Safety Considerations

a) Any wild animals encountered in an ecosystem study must be treated with caution.
b) Students should be warned that some plants in the schoolyard, at home, or on the site of field studies may be poisonous or may have been treated with poisons.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) study the effects of topographic features, such as the school building, on the strength and speed of the wind;
b) compare the growth patterns of trees in a forest with those on a suburban lawn;
c) investigate the effect of light duration on plant growth;
d) observe the response of animals to the intensity and quality of the light;
e) investigate how a plant is adapted for life in a dry environment.

8. Some Teaching Suggestions

a) All living organisms encountered in an ecosystem study should be treated in a humane and responsible manner.
b) Data sheets can be used to help students observe and record the basic components of ecosystems. Places near the school should be chosen so that observations can be made within one class period.
c) By comparing two different ecosystems, students will understand the uniqueness of each and at the same time the fact that though the components are different, they fulfil similar roles in each.
d) It should be emphasized that the purpose of field work is to study an area, not to destroy it.
e) The tundra is an easy biome to study, since the food chains are short, the diversity limited, and the adaptations pronounced.
f) Miniature ecosystems can be set up in plastic freezer bags (heat-sealed) or large cider jugs.

Optional Unit 1

Horticulture I

Time: 15 hours

The horticultural industry is a large and economically important part of the agricultural industry in Ontario. Moreover, gardening and the growing of houseplants are popular and widespread hobbies in Canada. Growing plants successfully requires the application of basic principles, which are introduced in this unit. Access to a greenhouse or to any good plant-propagation areas is essential for this unit. The time allocated to this unit can be spread over at least one term so that results from the various propagation procedures may be recorded and discussed.

This unit may be divided into topics such as the following:

- Basic requirements for plant growth
- Indoor and outdoor growing areas
- Preparing growing media
- Growing techniques
- Care of gift plants
- Growing a greenhouse crop

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a curiosity about the appropriate growing conditions for a variety of plants (2d);
b) an appreciation that plants provide us with food and attractive surroundings (3b, 4b, 4c).

Skills. Students will have the opportunity to develop skill in:

a) experimenting to determine if soil is necessary for plant growth (2a);
b) assessing methods of controlling the growing conditions in a greenhouse or other growing area (2b, 2d);
c) preparing a potting-soil mixture (2c);
d) pasteurizing soil (2c);
e) performing the following techniques: potting, watering, fertilizing, seeding, transplanting, labelling, repotting, maintaining equipment, propagating plants from softwood stem cuttings, pruning, and trimming (2d).

Knowledge. Students will be expected to:

a) define the term *horticulture* and state its usual divisions;
b) describe the range of possible career opportunities in horticulture;
c) list the basic requirements for plant growth;
d) describe how growing conditions are controlled in a greenhouse or other growing structure (2b);
e) explain the use of various structures for growing horticultural plants, for example, greenhouse, cold frame, hotbed, lath shelter, and cloth shelter (2b);
f) describe the purposes of and procedures for mixing and pasteurizing potting soil and explain the purpose of the various ingredients (2c);
g) list the organisms controlled by the pasteurizing of soil (2c);
h) give reasons for various growing techniques (2d);
i) give examples of annuals, biennials, and perennials, classified according to normal life cycles or method of culture;
j) describe methods of cuttage propagation (e.g., leaf, leaf bud, leaf petiole, leaf section, stem tuber, root tuber) suitable for different kinds of plants (2d, 2e);
k) describe suitable examples of plant propagation by division (2e, 2f);
l) describe the proper care of gift plants (e.g., a poinsettia or Easter lily) in the home;
m) name the steps in the culture of a greenhouse potted-plant or bedding-plant crop (2e).

2. Student Activities

Students are to:

*a) compare soil and an artificial medium (perlite or vermiculite) as the bases for plant growth;
*b) visit a greenhouse or other growing area and record the methods of controlling growing conditions;
*c) prepare and pasteurize potting soil (6b, 6c);

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*See the subsection entitled "Student Activities" on page 5.

*d) carry out a variety of growing techniques in a greenhouse or laboratory (8e);
e) propagate and grow a plant crop for use or sale (8d, 8e);
f) propagate plants from various types of cuttings and from division or separation (8c, 8f, 8g).

3. Applications

a) A potting soil suitable for house plants can be prepared.
b) Vegetables can be grown from seed and transplanted to the home garden.
c) Bedding plants can be propagated and grown in the home garden.
d) Conifers are grown from seed for use in reforestation.

4. Societal Implications

a) The horticultural industry is an important segment of the agricultural industry.
b) Potted flowers, house plants, and flower beds make our homes, other buildings in the community, and communities as a whole more attractive.
c) Raising home vegetables can be a method of increasing total food production, as well as providing an interesting and often profitable hobby.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory and greenhouse work;
b) records of plant-growth experiments;
c) projects and assignments.

6. Safety Considerations

a) Sharp tools must be handled with care.
b) Students should take care to avoid burns when pasteurizing soil.
c) Students should wash their hands after handling soils, fertilizers, and any other plant or soil chemicals.
d) All safety regulations must be followed if pesticides are used in the greenhouse.
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) determine the percentage of seeds of a particular variety that germinate;
b) investigate the light-intensity requirements for a growth panel;
c) investigate the types of lights required for a growth panel;
d) compare the growth of a greenhouse crop in regular potting soil and in an artificial medium;
e) propagate house plants vegetatively;
f) keep a monthly gardening calendar;
g) design a test for the germination rate of a specific seed type.

8. Some Teaching Suggestions

a) A growth chamber or greenhouse is necessary for teaching this unit.
b) Plants brought from home should be inspected carefully for pests.
c) By investigating different methods of cuttage, students can learn some basic botany (e.g., the names of basic plant structures).
d) The time needed to grow a crop will be longer than the time allocated to this unit. This unit can be integrated with other appropriate units in which plant growth is considered in order to provide longer periods of time for plant-growth experiments.
e) Students should practise performing the growing techniques, since the success of plant culture in later units depends on these techniques. Students should be evaluated on them.
f) A wick-watered propagating tray with sharp sand is excellent for showing the unusual methods of propagation by cuttage.
g) Students will require a wide variety of plants in order to practise the various propagating and growing techniques. Suitable sources should be located prior to beginning the unit.
h) Teachers should ensure that the sale of plants by students is in accordance with school board policy and acceptable to florists in the community.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 2

Forestry I

Time: 15 hours

Trees are the dominant form of plant found in a forest and the major modifiers of the forest ecosystem. Their loss or renewal has tremendous ecological effects. Forests are the basis of one of the largest industries in Canada and Ontario. This unit will promote an understanding of the forest ecosystem by studying the structures, processes, and cultural requirements of trees.

This unit may be divided into topics such as the following:

- Trees: general structures
- An interpretation of a tree's history
- The regeneration of trees
- Reforestation methods
- Forest management

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the many benefits provided by trees (3c, 4b);
b) an appreciation that trees are a renewable resource requiring very careful management (4a, 4d).

Skills. Students will have the opportunity to develop skill in:

a) inspecting and comparing the general structures of trees, including stem tissues and reproductive parts (2a, 2g);
b) planting tree seeds and seedlings (2g);
c) testing pieces of wood for lignin content (2e);
d) distinguishing between hardwood and softwood (2e);
e) collecting and stratifying seeds (2d).

Knowledge. Students will be expected to:

a) list and label the parts of a tree (crown, trunk, and root) and the main stem tissues (bark, sapwood, heartwood, springwood, and summerwood) (2a);
b) explain the growth in diameter of a tree stem or root (2c);
c) describe the natural and artificial regeneration of trees (2b, 2g);
d) describe nursery propagation of trees and cultural practices, including methods of seed collection, stratification, field and container culture, storage, lifting, and shipping;
e) explain briefly the following processes in trees: transportation of materials, growth, reproduction, and natural root grafting (2g);
f) briefly describe some common forest-management practices, such as clear cutting, improvement cutting, selective cutting, cleaning, clipping, pruning, timber cruising and mensuration, fire and pest control, and site preparation for regeneration;
g) describe common methods of reforestation, such as seeding, transplanting, and natural regeneration;
h) list many of the multitude of physical and aesthetic ways in which forests benefit people;
i) name the common forest communities of Ontario and list the dominant species of trees in each.

2. Student Activities

Students are to:

*a) compare cross sections of stems of various tree species (8c);
*b) compare the reproductive structures of various tree species (8c);
c) study the age and history of trees by examining cross sections or increment borer samples (8c);
d) collect and stratify tree seeds by mixing them with moist sand and refrigerating them (8c);
*e) test any two wood pieces for lignin content or for heat of combustion;
f) collect and examine pollen from staminate flowers produced by putting cut twigs of trees such as alder or birch in water and covering them with plastic (8c);
*g) grow forest trees from seeds or plant tree seedlings on the school grounds or in the community (8b, 8c);
h) compare the strength of selected hardwoods and softwoods.

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) The age of trees can be found from the cross section of the stem.
b) Suitable native trees or shrubs can be chosen for planting on a selected property.
c) Trees are planted to act as windbreaks on farms.
d) A knowledge of the qualities of the different kinds of wood makes it possible to choose wood for particular purposes (e.g., heating, lumber, pulp and paper).
e) A poor leader system on a conifer can be corrected by appropriate pruning.

4. Societal Implications

a) The management and harvesting of trees as a crop provides many jobs.
b) Trees provide us with many material benefits (e.g., lumber, food, fuel).
c) Controversy can result when trees are cut in public areas.
d) Reforestation after harvesting is often required to sustain a forest ecosystem.
e) The rapid destruction of forests in some areas of the world can affect both the ecology and the economy of those areas.

5. Evaluation of Student Achievement

At least 50 per cent of the evaluation for this unit is to be based on students':

a) laboratory work;
b) comparison charts and notes;
c) projects and assignments.

6. Safety Considerations

a) Students must be taught the safe use of tools such as pruners.
b) Students should take care to avoid poisonous plants, such as poison ivy, when walking in a forest.
c) Teachers should investigate the study site prior to the student visit.
d) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) carry out the destructive distillation of wood;
b) make paper from old paper and vegetable parts;
c) investigate the causes of seed dormancy and methods of overcoming it;
d) investigate the current market prices for firewood or timber;
e) set up a seed tray to collect falling tree seeds;
f) investigate the uses of tree pulp;
g) visit places such as a tree nursery, managed woodlot, reforested area, or forestry research facility and report on what they observe.

8. Some Teaching Suggestions

a) A field trip to an area such as a tree nursery, a woodlot, or a reforestation location would enhance this unit.
b) The school grounds can often be used for student activities, such as investigating or planting trees.
c) Materials for this unit should be collected and prepared in advance. These include cones, wood samples, stem cross sections, and twigs with staminate flower buds.

Optional Unit 3

Basic Gardening

Time: 15 hours

The propagation and growing of plants is an interest that many people enjoy pursuing at some time in their lives. This unit is designed to provide students with the knowledge and skills necessary to grow house plants, as well as outdoor fruits, flowers, and vegetables.

This unit may be divided into topics such as the following:

- Common plants for the home and garden
- Basic plant needs
- Propagating and growing plants
- The care of plants
- Natural or organic gardening
- Hydroponics

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the aesthetic and practical value of plants grown around the home (2d, 3c);
b) an appreciation for the economic advantage of growing fruit and vegetables for personal use (3a, 4a, 4b).

Skills. Students will have the opportunity to develop skill in:

a) identifying common house and garden plants;
b) using basic home-gardening tools and equipment (2a, 2b);
c) culturing, propagating, and caring for plants (2a, 2b, 2f);
d) observing and identifying the needs of plants that are not growing properly (2a, 2g);
e) designing and starting a home garden (2d);
f) choosing and preparing suitable locations for flower beds, vegetable gardens, fruit and shade trees, and windbreaks (2d);
g) propagating house plants, using seeds, cuttings, and layering techniques (2f).

Knowledge. Students will be expected to:

a) list and identify common shrubs and house and garden plants, both annuals and perennials;
b) state the general conditions necessary for healthy plant growth (2a);
c) identify methods of natural and artificial lighting for indoor plants (2f);
d) describe the basic steps in growing plants from seed, including scarification, sowing, germination, prevention of damping off, and thinning (2c);
e) list some common diseases and pests of house plants and identify the correct treatment, including both chemical and organic means (2g);
f) recognize signs of plant problems, such as wilting, off-colour leaves, leaf and bud drop, and root and stem rot;
g) state the meaning of the nutrient label on fertilizers and outline the effect of the various nutrients on plant growth;
h) discuss natural or organic gardening and compare it to gardening with chemicals;
i) list the materials needed for growing plants hydroponically and state the advantages and disadvantages of hydroponic gardening;
j) list at least three types of soil and describe methods of preparing soil;
k) state and demonstrate the precautions that are necessary in handling and using pesticides.

2. Student Activities

Students are to:

*a) perform a basic plant-growing experiment, varying essentials such as light, water, and nutrients (6b, 8a, 8b, 8f, 8g);
b) do experiments with different plants and pots to test the efficiency of the pots (8b, 8c, 8f);
c) experiment with germinating seeds to determine the variability and percentage viability in the rate of germination (8b-8d);
*d) draw up a plan for an indoor or outdoor garden (flowers or vegetables) (8b, 8c);
e) set up and maintain a hydroponic garden;

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*See the subsection entitled "Student Activities" on page 5.

f) experiment with house plants by varying the humidity, using different kinds and amounts of fertilizers, and starting plants from leaf and stem cuttings (6a-6c, 8a-8c, 8f);
g) grow plants in various conditions, such as under natural, fluorescent, and incandescent light (6c, 8a-8c);
h) collect some garden pests and examine them with a hand lens or a microscope.

3. Applications

a) Growing plants successfully gives one a feeling of confidence and accomplishment.
b) Homes can be made more attractive with gardens and house plants.
c) Shade trees help to keep a home cool in summer, break the wind, and may keep a house warmer in winter.

4. Societal Implications

a) As the population increases and farmland becomes scarce, home gardening can become more important for food production.
b) Fresh produce free of hazardous chemicals like pesticides can be produced in the home garden.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) ability to use and care for garden tools and equipment;
b) reports on plant-growing experiments;
c) maintenance of an indoor or outdoor garden.

6. Safety Considerations

a) The safety procedures outlined on the labels of chemicals such as fertilizers and pesticides must be followed.
b) Students should wash their hands carefully after handling soils, chemicals, or laboratory and greenhouse equipment.
c) Instructions should be provided for handling house plants that are poisonous or allergenic, such as dieffenbachia, new shoots of potatoes, rhubarb leaf blades, and daffodils.
d) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) calculate how much money a household can save by growing and preserving its own vegetables;
b) test house-plant fertilizers for the accuracy of their stated composition and for their effectiveness;
c) create deficiency diseases in plants and then try to correct the deficiency through the use of appropriate fertilizers.

8. Some Teaching Suggestions

a) Plants should be started or obtained in advance so that they will be ready when needed. Seeds collected for core unit 1 can also be used here.
b) Local professionals who raise plants can be invited to speak to students.
c) A visit to local nurseries, greenhouses, farms, home gardens, garden clubs, or botanical gardens would be worthwhile.
d) Small indoor greenhouses can be constructed. The technical department in a school may be able to assist with this task.
e) Plants started at school can be sold to the public on special occasions, such as Christmas and Easter.
f) Students should be encouraged to accept responsibility for the care of the plants used in this unit.
g) Natural gardening can be discussed throughout the unit when it is pertinent to the topics (e.g., fertilizers, control of diseases and pests).

Optional Unit 4

Living With Insects

Time: 15 hours

Insects are an important biotic component of the environment. They have endured for millions of years as a result of their ability to adapt rapidly to changing environmental conditions. Insects are both beneficial and harmful. They pollinate our crops, decompose waste material, transmit disease, and consume our crops. They are one of the most abundant and prolific groups of organisms on earth. This unit will help students to understand the role of insects in the environment.

This unit may be divided into topics such as the following:

- The structure, life cycles, and metamorphosis of insects
- The adaptation of insects to the environment
- The social organization of honey bees and termites
- Economically harmful insects
- Insects beneficial to humans
- Methods of controlling insects
- The role of insects in the environment

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the importance of insects as sources of food for other animals and as agents of pollination (3a);
b) an appreciation for the complex behaviour patterns of some species (3b);
c) an objectivity towards the need to control some insect species.

Skills. Students will have the opportunity to develop skill in:

a) observing adaptations of insects (2c);
b) using magnifiers to examine the body structures of insects (2c);
c) collecting evidence of insect activity (2a);
d) identifying the stages of metamorphosis (2b);
e) analysing the labels on insecticides and insect repellants (2f).

Knowledge. Students will be expected to:

a) list the stages in the life cycles of insects (2b);
b) identify adaptations of insects to the environment (2c);
c) describe the social behaviour of an insect such as the honey bee (2e);
d) identify some stinging and biting insects (2d);
e) explain the importance of insects in the environment (e.g., as agents of pollination);
f) name several harmful insects;
g) name several insects that are beneficial to humans;
h) describe chemical and biological methods of controlling undesirable insects (2g);
i) identify the safety precautions to be taken before using an insecticide or repellant (2f);
j) describe the first-aid treatment for some insect bites and stings.

2. Student Activities

Students are to:

*a) obtain evidence of insect activity in the local environment (e.g., damage done to plants and animals, by eggs, larvae, and adult insects; fly spotting on glass; mosquito bites; honey);
*b) compare the life cycles and behaviours of several easily obtained insects (e.g., aphids, ladybird beetles, grasshoppers, crickets, fruit flies, mealworms) (6a, 6b);
*c) examine, with magnification, the different ways in which some common insects are adapted for feeding, locomotion, and protection;
d) identify and collect samples of the stages in the life cycles of a biting insect and a stinging insect (6a, 6b);
e) examine a beehive in the field or the classroom and describe its social structure (6a, 6b, 8d);
f) read the labels of several insecticides and insect repellants, list the type of information recorded, and note any specific safety precautions;
g) examine the life cycles and behaviours of one or two insects that are harmful, such as mosquitoes, wireworms, spruce budworms, killer bees, termites, and earwigs (6a, 6b);

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*See the subsection entitled "Student Activities" on page 5.

h) examine the life cycles and behaviours of one or two beneficial insects, such as honey bees (6a, 6b);
i) devise an experiment to compare the effectiveness of several insect repellants (6b, 6c).

3. Applications

a) Beekeeping is an occupation in which people benefit from insects.
b) A knowledge of insects' life cycles and of insecticides helps us to control insects in the home, to protect ourselves from insects in the out-of-doors, and to reduce insect damage to gardens, fields, and forests.
c) By using integrated pest management, one can decrease the use of chemical pesticides.

4. Societal Implications

a) Some species of insects tend to develop immunity to insecticides, thus requiring the development of new insecticides.
b) Insecticides that kill harmful insects (target species) may also kill those that are beneficial (non-target species).
c) Insecticides such as DDT may appear beneficial at first but may actually damage the entire ecosystem.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) descriptions of insect adaptations;
b) ability to identify stages in various insect life cycles.

6. Safety Considerations

a) Students should be surveyed for allergies to insect stings or bites prior to working with live insects.
b) Students should take appropriate safety precautions when testing insect repellents.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Students might:

a) study the migration patterns of insects (e.g., that of the Monarch butterfly);
b) study garden or forest insects, both harmful and beneficial;
c) study other classes of arthropods (e.g., Arachnida);
d) discuss insect reproduction and the way in which insects become resistant to insecticides;
e) discuss methods of controlling insects at different stages of their life cycles.

8. Some Teaching Suggestions

a) The role of insects in the environment should be emphasized throughout the unit.
b) Examples should be given of the relationship between insects and human disease.
c) The adaptations of insects to their environments should be stressed.
d) A visit to an apiary can enhance this unit.
e) Examples of common insect pests and the methods of controlling them should be provided.
f) The use by entomologists of a knowledge of insect life cycles to control insects should be discussed.

Optional Unit 5

Agricultural Crop Science I

Time: 15 hours

Canadian agricultural crops help to meet the world's demand for food. About half of all the arable land in Canada produces the principal cereals – corn, wheat, rye, barley, oats, and soybeans. The rest of the arable land is used primarily for forage crops, fruits, and vegetables. The production of crops requires an understanding of the structure of plants, their chemical processes, and the environmental conditions they require.

This unit may be divided into topics such as the following:

- Cereal crops
- Forage crops
- Fruit crops
- Oil crops

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that field crops are essential to human survival;
b) an appreciation that field crops have specific environmental requirements (3a, 3e).

Skills. Students will have the opportunity to develop skill in:

a) comparing the morphological features of various field crops (2a, 2c);
b) classifying various field crops according to structure and economic uses (2c);
c) identifying the seeds and mature plants of some cereals and forages (2a);
d) identifying some common fruit trees (2f);
e) planting and growing selected crops (2b).

Knowledge. Students will be expected to:

a) describe the common characteristics of field crops (2f);
b) describe the common features of selected groups of field crops (e.g., cereals, oil crops, forages, fruits);
c) list the principal agricultural crops in Canada (2f);
d) describe the importance of Canadian agricultural crops;
e) investigate the world demand for field food products;
f) describe the history of the cultivation, harvesting, storage, and processing of two common crops over the past two hundred years;
g) describe the structure and economic use and give examples of the following types of field crops: cereals, forages (legumes and grasses), oil crops, root and tuber crops, fibre, and fruit (2a, 2c);
h) state the ideal growing conditions for at least three fruit crops and describe the methods of storing and processing the crops;
i) name the essential growth factors of at least four or more oil crops;.
j) name some common field crops that are good sources of protein, energy, liquids, and minerals;
k) describe the design of farm implements used for planting at least two cereal crops.

2. Student Activities

Students are to:

*a) examine the seeds of selected vegetables, cereal grains, and forages, such as oats, barley, wheat, corn, soybeans, alfalfa, timothy, and trefoil, and relate the growth habits of the plants to the production of the seeds (6a, 8a);
*b) plant seeds from selected cereals, forages, or vegetables and vary the conditions (light, heat, moisture, soil fertility) under which the plants are growing (6a);
*c) dissect specimens of selected food plants and observe the internal structure of the roots, stems, leaves, fruit, and seeds (6a, 8a);
d) observe planting methods for field crops, such as corn, wheat, and tomatoes (8a);
e) observe and plan the management of various field crops, including the use of pesticides, cultivation, irrigation, drainage, and harvesting (6b, 8a-8c);
f) visit a nearby farm and observe the field, vegetable, and fruit crops (6a, 8a).

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) A knowledge of the requirements of various plants makes it possible to choose the one best suited to a particular region.
b) Field crops are used as substitutes for animal-based foods (e.g., soybeans are used as a meat substitute).
c) Harvested field crops provide a wide variety of processed food products.
d) Methods of cultivation and harvesting depend on local conditions.
e) Crops must be grown according to the type of land and the climate of the district.

4. Societal Implications

a) Many field crops provide seasonal work for pickers.
b) The successful production of field crops depends on critical management decisions.
c) Long-range decisions must be made concerning the best use of a field crop (e.g., as cattle feed or for human consumption).
d) Farmers must use their land wisely in order to produce crops in the future sufficient to feed an increasing human population.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) recognition of plant species grown in Ontario and their products;
b) oral and written reports of planting experiments and other activities.

6. Safety Considerations

a) Students should wash their hands after handling soil, chemicals, or treated seeds.
b) Students must follow recommended safety precautions when applying pesticides.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) investigate the agricultural practices in a selected developing country;
b) compare the growth rate of selected varieties of the same crop.

8. Some Teaching Suggestions

a) A visit to a nearby feed mill, flour mill, fertilizer company, or farm can add interest to the unit.
b) A visit to a local fall fair or the Royal Agricultural Winter Fair can be worthwhile.
c) The field crops grown in the region can be discussed with a local representative of the Ministry of Agriculture and Food.

Optional Unit 6

Locally Designed Unit

Time: 15 hours

This unit is to be designed at the local level as desired. It can be used to introduce a new area or topic of environmental science not described in this guideline or to incorporate additional objectives that will expand a part or parts of the course already covered. The following are examples of areas or topics that might be considered: ecology, agriculture, horticulture, forestry, outdoor studies, environmental issues, pollution, natural resources.

This unit may provide an excellent opportunity for students to engage in independent study on a topic in environmental science that is of particular interest to them and that is approved, monitored, and evaluated by the teacher. Students may work individually or in small groups. Care should be taken not to allow the work to overlap with subject matter in other environmental science or science courses that students are likely to take. The unit could be started after students have had some experiences in the laboratory and are well aware of accident prevention. If a series of short topics is considered, these topics may be fitted into the course schedule from time to time throughout the semester or year.

A locally designed unit is to incorporate components similar to those adopted in the core units, namely, objectives, student activities, applications, societal implications, and safety considerations. An outline of the unit is to be included with the school's course of study and kept on file so that it is available to interested students and parents.

Environmental Science, Grade 11, General Level
(SEN3G)

Core Units

Energy Pathways
Plant Science II
Animal Science *or* Wildlife Biology
Aquatic Ecosystems

(65 hours)

Optional Units

Horticulture II
Forestry II
Agricultural Crop Science II
Landscaping I
Garden Maintenance
Noise Pollution
Outdoor Skills
Locally Designed Unit

(45 hours)

Core Unit 1

Energy Pathways

Time: 16 hours

Organisms are dependent on the energy they can obtain within their ecosystem. This unit deals with the flow of energy in both natural ecosystems and the modified ecosystems of agriculture. It examines and compares the pathways of energy from producers to consumers, the efficiency with which energy is converted and stored, and the dependence of people on the energy obtained from food.

This unit may be divided into topics such as the following:

- Energy flow in natural ecosystems
- Energy loss
- The pyramid of energy
- Energy flow in agriculture
- Human energy requirements

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the value of plants in producing food as a source of energy (3e);
b) a concern for the amount of energy used in producing and processing food (3c, 3d);
c) an appreciation that energy input is an important factor in the cost of foods (4a).

Skills. Students will have the opportunity to develop skill in:

a) designing and performing experiments (2a, 2d);
b) comparing the energy content of several foods (2b, 2g);
c) organizing and diagramming the energy flow in an ecosystem (2e);
d) collecting information regarding energy requirements (2f).

Knowledge. Students will be expected to:

a) explain diagrams of the energy flow in a natural or an agricultural ecosystem (2e);
b) compare matter and energy cycles in an ecosystem (2a, 2e);
c) explain the various ways in which energy is lost to the ecosystem, for example, through respiration, death, waste production, and body heat (2c-2e);
d) describe how the components of an ecosystem are involved in the food-production process (2e);
e) describe how agricultural operations use energy to reduce competition among species, increase yields, and save labour (8c);
f) explain the significance of the pyramid of energy as it relates to energy flow (2e);
g) compare the energy content and the energy of production of some common foods (2b, 2g, 8e);
h) compare the energy input and the land area required to support a vegetarian diet and an omnivorous diet (2g);
i) describe the advantage gained by selecting foods on the basis of the energy they require for production and processing (2g).

2. Student Activities

Students are to:

a) perform an experiment to illustrate that sunlight contains energy;
*b) design and carry out experiments to compare the energy content of several foods, such as butter, lettuce, and peanuts (6a);
c) demonstrate that heat is generated by living plants, such as germinating seeds (8g);
d) design and carry out an experiment to show that heat is generated by decomposers (e.g., damp hay or compost);
*e) draw a diagram of the energy flow in an ecosystem, showing energy conversions and losses (8a);
f) investigate the amount of energy needed by a resting and an active mammal;
*g) conduct a library research project to compare the amount of land that is needed to produce food for one person on a vegetarian diet with that needed to support one person on an omnivorous diet (8d).

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) A knowledge of energy relationships helps ecologists manage ecosystems.
b) The management of an ecosystem can provide more energy-efficient food.
c) Tillage methods can be modified to reduce the amount of energy used.
d) Some crop strains are more energy-efficient than others.
e) Growing food for personal use can reduce the energy used in food production.

4. Societal Implications

a) The cost of energy-intensive methods of producing, processing, and transporting food is reflected in food prices.
b) Agricultural practices that increase efficiency may depend on energy-intensive products, such as chemical fertilizers and pesticides.
c) Changes in the food preferences of consumers have a direct effect on the agricultural industry.
d) Consumers' choice of food is influenced more by advertising, palatability, and packaging than by the energy-efficiency of the product.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) diagrams of the energy flow in an ecosystem;
b) ability to design and perform experiments;
c) assignments and projects.

6. Safety Considerations

a) Goggles should be worn if food samples are burned.
b) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) calculate the energy content of the food wasted in the school cafeteria;
b) examine livestock rations and suggest ways of reducing the energy used to produce them;
c) compare the frequency of advertisements for unprocessed and processed foods;
d) investigate the feeding of waste products to livestock.

8. Some Teaching Suggestions

a) The loss of energy in the form of heat at each trophic level of the energy pyramid should be emphasized.
b) Energy conservation in food production, processing, and transportation and in the choice of foods should be stressed.
c) When the energy efficiency of agricultural methods is being discussed, the energy used in producing farm machinery, pesticides, and chemical fertilizers should be included.
d) A vegetarian can be invited to speak to the class.
e) The meaning of the unit calorie as it is used in diets should be explained.
f) Students should identify the renewable and non-renewable energy used in producing food.
g) A Dewar flask can be used to show the heat generated by germinating seeds. The heat generated can be attributed to respiration.

Core Unit 2

Plant Science II

Time: 16 hours

The growing of plants in the home, garden, field, or forest requires an understanding of plant anatomy and of the basic factors that influence growth. An understanding of the complexities of plant culture should prepare students for more advanced studies of plant culture in the units on horticulture, crop science, and forestry.

This unit may be divided into topics such as the following:

- Plant structure
- Factors affecting the growth of plants
- Photosynthesis
- Plant reproduction
- Mineral nutrients

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the complexity of plants (2);
b) a respect for the scientific principles that must be applied during plant culture (2a);
c) a curiosity in finding answers about plant growth through experimentation (2b).

Skills. Students will have the opportunity to develop skill in:

a) designing and conducting experiments to investigate plant structure and growth (2c);
b) handling and culturing plants and parts of plants (2);
c) using minute concentrations of plant regulators (2a, 2d);
d) measuring abiotic factors, such as humidity, light intensity, and temperature (2c);
e) designing an experiment to show the relationship between temperature or light intensity and photosynthesis (2c).

Knowledge. Students will be expected to:

a) describe the role of plants in the ecosystem;
b) identify conditions for the successful rooting of cuttings (2a);
c) describe how plants adjust to changing conditions;
d) recall the names for the parts of a plant and the parts of a flower;
e) label a diagram showing the parts of a plant and the parts of a flower;
f) explain briefly the following processes: pollination, seed development, germination, photosynthesis, respiration (2);
g) describe the functions of leaves and stems (2b, 2c);
h) list the various factors that affect plant growth (2c, 2h);
i) describe the effects of various environmental factors on plant growth (2c);
j) describe the role of nutrient fertilizers and growth regulators in plant growth (2h);
k) describe the effect of acid deposition on plant growth (2d).

2. Student Activities

Students are to:

a) design and carry out an experiment to determine the effect of a rooting hormone on stem cuttings (6a, 6b);
b) design and carry out an experiment to investigate the gaseous exchange in leaves (8d);
*c) design and perform an experiment to study how factors such as light intensity and temperature affect the rate of photosynthesis (8b, 8e);
*d) carry out an experiment to illustrate the effects on plants of factors such as growth stimulators and inhibitors and acid deposition (6a);
e) carry out an experiment to investigate the role of pollination in seed production;
f) design and carry out experiments to investigate geotropism or phototropism;
g) investigate the role of humidity in successful propagation by rooting cuttings;
h) perform an experiment to determine the value of various mineral nutrients in different concentrations (6a, 8c).

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) Beehives are placed in orchards to ensure that pollination and fruit-set occur.
b) Agricultural crops are selected according to the growing conditions available, such as the type of soil, the number of frost-free days, and the local heat-unit value.
c) Natural gas and propane are burned in greenhouses to increase the amount of carbon dioxide around the plants.
d) The weed killer 2,4-D is a plant-growth stimulator that kills by causing broad-leafed plants to outgrow the supply of nutrients available to support the plants' growth.
e) Indoor chrysanthemums are sprayed with a growth inhibitor so that they will stay short and bushy.

4. Societal Implications

a) The widespread spraying of insecticides may interfere with plant pollination by reducing the population of insect pollinators.
b) The land that is suitable for agriculture is limited and needs to be protected.
c) A worldwide increase in atmospheric levels of carbon dioxide may stimulate plant growth.
d) The careful management of a woodlot can increase the amount of wood that is available.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work;
b) ability to design and carry out experimental work;
c) projects or assignments.

6. Safety Considerations

a) Students should wash their hands after using chemicals (e.g., fertilizers, hormones).
b) Students should use protected blades when making cuttings of plant material.
c) Students should be warned not to eat any of the plant material studied.
d) Students should be surveyed regarding allergies to plant materials prior to their handling of any specimens.
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) grow plants in a synthetic growing medium;
b) investigate the role of plant auxins in plant growth;
c) investigate the effects of the length of the day on the flowering of poinsettias and chrysanthemums;
d) investigate the effects of light of various colours and intensities on plant growth.

8. Some Teaching Suggestions

a) This plant unit can be integrated with other units of the course that are related to plant studies (e.g., horticulture). Integrating this unit can provide increased time for plant-growth experiments.
b) If access to sufficient light for plant growth is a problem, fluorescent lights can be set up in the classroom; alternatively, the plants can be taken home by students and the appropriate observations made there.
c) All plant experiments dealing with nutrient assessment should be done with an inert medium such as vermiculite and plants that have matured past the stage of cotyledon drop.
d) The need for gaseous exchange in leaves can be demonstrated by coating some leaves with petroleum jelly and comparing the starch content of these leaves after a few days with that of uncoated leaves.

Core Unit 3a

Animal Science

Time: 16 hours

Teachers must select either this unit or the unit "Wildlife Biology" as part of the core content of this course. The unit not selected may be considered as one of the optional choices.

Wild and domestic animals alike interact with their physical environment, with other animals, and with the human population. This unit will give students the opportunity to investigate various aspects of wild, farm, and pet animals.

This unit may be divided into topics such as the following:

- Wild animals
- The dairy industry
- The beef industry
- The swine, sheep, or horse industry
- The poultry industry
- Pet animals

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a concern for the responsibility assumed by humans when they care for animals (3d);
b) an appreciation for the importance of selective breeding in producing better animal products for human use;
c) a concern that meat is an energy-intensive food eaten mostly in developed countries;
d) a questioning attitude towards the process of selective breeding as it relates to the general welfare of the species.

Skills. Students will have opportunities to develop skill in:

a) observing the diversity of wild and domestic animals (2a);
b) comparing the habitats of various animals (2b);
c) using laboratory equipment to separate milk and to test milk for lactose, protein, and fat (2d, 2e);
d) summarizing information in the form of a report (2g).

Knowledge. Students will be expected to:

a) explain, using examples, how wild or domestic animals interact with their environment (2a, 2b);
b) list the responsibilities a person assumes when looking after a wild or domestic animal (2k);
c) state some ways in which humans and wild animals affect one another; for example, humans destroy animal habitats, hunt and trap animals, and practise pest control; animals destroy livestock and crops (2a);
d) explain how selective breeding often improves the quality of some aspects of the animals but may be harmful to the species in general (e.g., by producing a beef cow that cannot support its young);
e) list several breeds of farm animals, such as dairy cattle (2c);
f) state the composition of milk from a dairy cow (2e);
g) explain the importance of records to milk production (2e);
h) describe some tests used to control the quality of milk (2e);
i) state the chief processes (slaughtering, grading, feeding, maintaining health, and housing) in the beef industry, the poultry industry, and the swine or sheep industry (2c);
j) list the reasons why people keep pets and discuss some of the things to be considered when choosing a pet (2h);
k) explain how a particular pet animal should be fed, trained, and cared for (2h);
l) describe some of the problems caused by irresponsible owners of pets (2h).

2. Student Activities

Students are to:

*a) study a pond, stream, marsh, or alternatively an aquarium in the classroom, identify as many forms of animal life as possible, and note their places in various food chains (6a, 6c);
b) visit or observe pictures or slides of habitats in a zoo and compare these to the animals' natural habitats (8a, 8e);
c) construct a chart illustrating in detail the life cycle of one farm animal;
d) separate milk with a centrifuge (6c);
*e) test milk for lactose, protein, or fat (6c);

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*See the subsection entitled "Student Activities" on page 5.

f) compare human-made fibres with wool under a microscope and perform dyeing, stretching, and strength tests on various fibres;
*g) prepare a summary of farm-market reports and investigate trends in prices and production (8c, 8d);
h) investigate the needs of a specific pet and develop and maintain a suitable environment for it (8b, 8d, 8e);
i) conduct a library research project to determine the efficiency with which various animals turn grain into protein or body mass.

3. Applications

a) An interest in animals may lead to hobbies or careers in animal husbandry, animal welfare, wildlife biology, or conservation.
b) A knowledge of the meat and dairy industries helps consumers to make intelligent decisions about the food they buy.
c) Information obtained from a farm-market report can be used to predict trends in food costs.
d) A knowledge of the life cycle of an animal can lead to a better understanding of how to care for the animal.

4. Societal Implications

a) Wild animals are affected directly by many kinds of human activity.
b) Consumer food prices may be directly related to production costs.
c) Pets that are not looked after properly may suffer, bite people, kill livestock and wild animals, spread rabies, or cause sanitary problems.
d) Society has developed laws against the mistreatment of animals.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work;
b) records of experiments;
c) written reports.

6. Safety Considerations

a) Caution should be exercised in the handling of any wild animal.
b) If live vertebrate animals are in the classroom, the regulations of the Animal Care Act must be followed.
c) Rules for personal hygiene when handling animals, chemicals, and laboratory equipment should be established and followed.
d) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) conduct an in-depth study of a zoo animal;
b) debate the issue of animal rights;
c) do the Babcock test on milk;
d) make butter, cheese, yogurt, or sour cream in class;
e) compare the beneficial and detrimental effects of selective breeding;
f) study the uses of animal hides;
g) conduct a cost-benefit analysis on keeping a pet for one year.

8. Some Teaching Suggestions

a) Students can discuss the care and housing of zoo animals and the animals' natural habitats with zoo personnel.
b) The nutritional value of samples of food for various animals can be compared.
c) Students can visit a local meat market to investigate the kinds of meat and the meat cuts that are most often purchased by consumers.
d) A veterinarian, wildlife biologist, farmer, horse trainer, dog trainer, or another person who works with animals can be invited to the classroom to speak to students.
e) A member of an animal-rights organization can be invited to address the class.
f) Teachers should emphasize the importance of studying a habitat without destroying it.

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*See the subsection entitled "Student Activities" on page 5.

Core Unit 3b

Wildlife Biology

Time: 16 hours

Teachers must select either this unit or the unit "Animal Science" as part of the core content of this course. The unit not selected may be considered as one of the optional choices.

Wildlife is one of the main components of any ecosystem in Canada. This unit is intended to help students understand the behaviour and needs of some species of Canadian wildlife as well as examine the factors that influence the well-being of the various species. From this study some students may develop an interest in wildlife biology as a career.

This unit may be divided into topics such as the following:

- Canadian wildlife
- Wildlife habitats
- Population ecology
- Wildlife management
- Endangered species

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the value of wildlife to humans (2c);
b) a commitment to protect animals that are in danger of extinction (4a, 4c);
c) an appreciation for the diversity of wildlife in Canada (2a);
d) a commitment to maintain and increase wildlife habitats for the future (3c);
e) an appreciation that they should use caution when they encounter animals in the wild (4b, 4e).

Skills. Students will have the opportunity to develop skill in:

a) identifying species of wildlife (2a);
b) recognizing the destruction of a habitat (2e);
c) investigating environmental problems that affect wildlife (2d);
d) collecting data in the field on wildlife populations and organizing and graphing these data (2a).

Knowledge. Students will be expected to:

a) identify various species of Canadian wildlife (2a, 2c);
b) list the ways in which wild animals are beneficial to people (2c);
c) identify the species of wildlife normally found in various habitats (2a);
d) identify the components of food webs (2b);
e) describe the effects of modifying a habitat for wildlife (2e, 2f);
f) describe the mating habits and territoriality of several species of wildlife (2f);
g) interpret population growth curves;
h) explain why human interference has often necessitated the management of wildlife to ensure its survival (2f, 2h);
i) identify the principal endangered species in Canada (2h);
j) explain the role of various private and public agencies in the management of wildlife.

2. Student Activities

Students are to:

*a) map and identify various species of animals within a specific habitat (6a, 8b, 8c);
*b) examine various ecosystems and draw food webs that show primary, secondary, and tertiary consumers; producers; scavengers; and decomposers;
c) compile a list of wild animals used by humans, giving details of the population density of each and the purpose for which each animal is used;
d) choose a local habitat and examine methods of improving it (6a, 8b);
*e) study the effects on the fauna in an ecosystem of the modification of their habitat (e.g., as a result of highway and pipeline construction);
f) study territoriality in a specific species and estimate the size of the food supply and the living space that it requires;
g) compare the local and provincial hunting and fishing regulations and outline factors that should be considered in their establishment;
h) obtain an up-to-date list of endangered Canadian species and determine why each is endangered (8d).

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) Hunting and trapping contribute to the Canadian economy.
b) Hunting and fishing are popular leisure pursuits in Canada and bring many tourists into the country.
c) Natural-resource authorities are working with landowners to preserve and establish wildlife habitats.
d) Properties can be modified through landscaping to attract wildlife.
e) Hunting and fishing regulations assist in wildlife management.

4. Societal Implications

a) Some Canadian species are being threatened by hunting and other human activities.
b) Wild animals can become troublesome when their habitat is influenced by human activity (e.g., bears at a landfill site).
c) The survival of wildlife often takes second place to such human activities as farming, residential construction, and oil exploration.
d) Wilderness parks often bring people into contact with species of wildlife rarely seen in cities.
e) Wild animals sometimes carry diseases that are communicable to people.
f) Many people view hunting and trapping as inappropriate uses of wildlife.
g) The viewing of wildlife is a pleasurable experience for most Canadians.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) projects and assignments;
b) fieldwork;
c) notes and records.

6. Safety Considerations

a) Appropriate precautions must be established prior to the study of an outdoor habitat.
b) Students should wash their hands after handling animals in the field or the laboratory.
c) Wild animals that exhibit strange behaviour should not be approached.
d) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) modify the habitat of a local wild species by, for example, setting out bird feeders or nesting boxes;
b) examine the trapping industry by researching the laws, types of fur-bearing animals, and methods of trapping;
c) discuss how wildlife-protection laws should be implemented;
d) investigate the effect of agriculture or industry on a specific species;
e) study a specific behaviour of a particular species, such as the courting and mating habits of the spruce grouse, by direct observation in the field;
f) examine the browse line of deer in a nearby wooded area.

8. Some Teaching Suggestions

a) Guest speakers, such as conservation officers, wildlife biologists, and naturalists, should be invited to the classroom whenever possible.
b) Students should be encouraged to take a field trip to a nearby conservation area to study examples of good and poor habitat management.
c) Published information from various public and private agencies, such as the Canadian Wildlife Service or the Federation of Ontario Naturalists, can be used.
d) Students can visit a nearby zoo or museum to see examples of endangered species.
e) The class might debate an issue pertaining to wildlife.
f) Natural habitats should not be destroyed or disturbed on field trips.

Core Unit 4

Aquatic Ecosystems

Time: 17 hours

In this unit students have the opportunity to extend their knowledge of ecosystems to include a detailed study of an aquatic ecosystem. Particular attention is given to the influence of humans on such ecosystems. Through selected activities the conditions required to support life in a selected freshwater ecosystem are examined.

This unit may be divided into topics such as the following:

- Freshwater ecosystems
- Physical, chemical, and biological aspects of aquatic ecosystems
- Index species and the diversity of species
- Eutrophication
- Water quality
- The importance of plants

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the importance of water as a natural resource;
b) an appreciation for the sensitivity of aquatic species and ecosystems to changes in the characteristics and quality of the water (4b, 4c);
c) an appreciation for the need to consider the quality of the water when making decisions that affect the environment;
d) a respect for the role of each species within an ecosystem (4c).

Skills. Students will have the opportunity to develop skill in:

a) using field and laboratory techniques to analyse water (2b);
b) using the microscope to examine prepared slides and living cultures of algae and other aquatic organisms (2d);
c) recording data from a water analysis in tabular form (2b, 2c, 2e);
d) interpreting data obtained from a water analysis (2b).

Knowledge. Students will be expected to:

a) name and describe various types of freshwater ecosystems, including descriptions of typical food chains, and outline specific adaptations of some of the organisms in each (2a);
b) describe the abiotic characteristics of a selected aquatic ecosystem (2b);
c) explain the meaning of the term *index species;*
d) establish a relationship between water quality and the diversity of species (2c, 2e);
e) explain the meaning of the term *eutrophication* and describe the factors that contribute to natural eutrophication and to eutrophication caused by humans (2e, 2h);
f) state the effects of domestic, agricultural, and industrial effluents on the quality of water, on the diversity of species and the size of populations in the Great Lakes, and on indicator species in rivers, ponds, and lakes (2e, 2h);
g) relate changes in the diversity of algae to changes in water quality (2d);
h) explain how fecal bacteria relate to water quality and state and interpret the provincial standards for drinking water and swimming beaches (2g);
i) describe how acid deposition affects the pH of lakes, ponds, streams, and soil (2b).

2. Student Activities

Students are to:

a) illustrate food chains for freshwater ecosystems by means of drawings;
*b) analyse water from a nearby body of water or a classroom ecosystem for abiotic factors, such as temperature, oxygen, pH, carbon dioxide, and hardness (6a, 6b, 8a, 8b);
c) conduct a field study of a local aquatic ecosystem, find the kinds and sizes of populations of water organisms representative of the water, determine the water quality indicated by the presence of those organisms, and relate the abiotic properties of the water to the organisms present (6b, 6d, 8c, 8e);

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*See the subsection entitled "Student Activities" on page 5.

*d) examine prepared slides and a living culture of algae;
e) observe stages in succession in a pond ecosystem (8f);
f) set up a closed freshwater ecosystem and observe it for a few weeks;
g) determine the coliform count of water by using membrane filtration or Millipore's "coli-count samples" (6b-6d, 8a);
h) determine the effects on water quality of an increase in the mass of organic matter (8d).

3. Applications

a) The hardness of water is indicated by the scale that builds up in a kettle and by the ring around a bathtub.
b) High nitrate levels in water are often a result of animal wastes and farm run-off.
c) Chemicals are used in swimming pools to prevent the growth of algae.
d) Algae in lakes and ponds may indicate the presence of excess nutrients.
e) Eutrophication may be enhanced by soil erosion.
f) Acid deposition may lower the pH of natural water systems to the point where certain species are affected.

4. Societal Implications

a) Humans have drained standing waters, causing a decrease in some wildlife populations.
b) Dams are built across running water, creating bodies of standing water and thereby changing the entire ecosystem.
c) Organic wastes added to rivers may eventually increase the demand for dissolved oxygen. This will affect the types of species in the water.
d) Acid deposition is a serious threat to the quality of the water in many aquatic ecosystems.
e) Oil spills reduce the biotic potential of aquatic ecosystems.
f) Phosphates and nitrates in run-off may cause algae to grow in lakes and ponds.
g) The salt used on roads in winter eventually enters various waterways, where it may affect the aquatic ecosystems.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) ability to collect and interpret water-analysis data;
b) assignments, diagrams, and records of experiments.

6. Safety Considerations

a) Test solutions used for water analysis should be labelled and have self-contained droppers.
b) Students should be informed that any water sample they are studying may contain harmful bacteria.
c) Students should follow appropriate procedures when doing coliform counts.
d) Students should follow the rules for personal hygiene when handling animal tissues, live animals, or coliform-count materials.
e) Field trips should not be conducted to rivers that are heavily polluted with sewage.
f) Appropriate safety procedures must be followed on field trips.
g) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) conduct a long-term study of a mini-ecosystem (e.g., an aquarium);
b) conduct a library research project on the effects of water contaminants such as mercury, dioxin, and PCBs on natural water systems.

8. Some Teaching Suggestions

a) The results of the water tests can be compared to the standards for drinking water.
b) When studying a local aquatic ecosystem, students should identify both the dominant organisms in the system and the indicator species that are normally found in a balanced ecosystem.
c) The effects of organic matter on the quality of the water in a mini-ecosystem can be studied. The effect of pollution on eutrophication should be stressed.
d) Resource documents available from government ministries and industry can be used to help students identify fish.
e) The memorization of the specific names of algae should not be required.
f) Students can study succession in the laboratory by preparing hay infusions and observing them for several weeks.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 1

Horticulture II

Time: 15 hours

An understanding of plant-culturing techniques has made possible the production of a great variety of domestic fruit crops. For example, mutations that have occurred in plants by chance or by design have often been preserved by vegetative propagation to produce plants that are prized for their beauty or productivity. In this unit students will investigate the application of various plant-culture techniques to horticulture.

This unit may be divided into topics such as the following:

- Growing plants indoors
- Sexual propagation
- Asexual propagation
- Plant modification
- Fall care of plants
- Greenhouse crops

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that horticulture involves the application of scientific principles to the improvement of crop production (3b);
b) a curiosity about the methods used by horticulturists to improve plant characteristics (3b).

Skills. Students will have the opportunity to develop skill in:

a) growing plants in the classroom or potted plants and bedding plants in a greenhouse (2a, 2i);
b) dissecting plant structures (2f);
c) collecting and planting tree seeds (2b);
d) propagating plants by taking various kinds of cuttings and by grafting (2c-2e);
e) determining the factors that stimulate the growth of cuttings (2d);
f) pruning flower crops and woody material (2g, 2h);
g) identifying house plants and local crops.

Knowledge. Students will be expected to:

a) give examples of types of house plants (e.g., tropical, foliage, flowering);
b) outline the requirements of house plants and the methods of meeting these requirements (2a);
c) describe several cultural techniques, including repotting, pinching, and clearing;
d) describe the construction of a terrarium;
e) distinguish between sexual and asexual reproduction and outline the advantages and disadvantages of each (2b, 2c);
f) explain the reasons for dormancy in many seeds and give methods of overcoming it (2b);
g) describe several methods of propagating plants, for example, layering; cuttage of hardwood, softwood, and evergreen stems; cleft grafting; T-budding; division and separation; and propagation by spores, bulbs, and corms (2c, 2e);
h) explain the conditions necessary for successful grafting (2e);
i) distinguish between training and pruning, heading back and thinning out, reproductive and vegetative growth, and pinching and disbudding (2g, 2h);
j) explain the types of tree growth, including central leader, open centre, and espalier (2h);
k) name suitable times and suitable equipment for pruning plants and describe the effects of various pruning practices;
l) suggest several methods of inducing reproductive growth in trees, including root pruning and plant orientation;
m) describe the injury to plants caused by rodents and winter weather conditions and list methods of protection;
n) describe steps in the culture of a greenhouse crop (2i).

2. Student Activities

Students are to:

*a) propagate plants and keep records of their growth in the classroom or greenhouse (8a, 8c, 8d);
*b) collect, store, and plant tree or shrub seeds and keep records of the new growth (6b, 8e);
*c) take, insert, and root two types of cuttings, such as hardwood and softwood (6a);

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*See the subsection entitled "Student Activities" on page 5.

d) test various factors that stimulate growth from cuttings, such as the size of the cutting, the rooting medium, hormones, the bottom heat, or the maturity of stock (6a);
e) practise cleft grafting with, for example, wild crab-apple stems (6a, 8f);
*f) observe and dissect such plant structures as rhizomes, runners, and bulbs (6a);
*g) pinch or disbud a greenhouse crop or house plant and describe the effect on the plant;
h) prune an evergreen branch so as to hide the cuts (6a);
i) grow a crop of potted flowers or bedding plants to maturity.

3. Applications

a) Vegetative propagation has been used to produce exact genetic copies of some of the best ornamental plants and commercial fruits (e.g., McIntosh apple).
b) A knowledge of the principles of pruning and propagation has made it possible to increase the productivity of many commercial plants (e.g., sweet cherry, geranium).
c) A dwarf apple tree can be trained on an espalier to save space on a city lot.
d) A new evergreen for a home garden can be produced by layering a branch.
e) The trunks of young trees are covered with plastic or oils to prevent girdling by rodents.
f) An injury to a favourite tree can often be repaired by bridge grafting.
g) The humidity can be increased for a house plant by setting the plant in a tray of water and stones.
h) Chrysanthemums to be used for cut flowers can be disbudded to produce larger blooms.

4. Societal Implications

a) The shape and beauty of ornamental shrubs and trees in parks and homes can be maintained by using proper pruning principles.
b) Many careers are available in areas relating to horticulture.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory and greenhouse work;
b) science notes;
c) projects and assignments.

6. Safety Considerations

a) Students should take appropriate precautions when using pruning equipment and knives.
b) Students should be asked to report any allergies to plant materials to the teacher.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) demonstrate additional methods of propagation (e.g., peaches can be budded in early September, hyacinth bulbs can be scooped from September to November);
b) practise soft-wood cuttage if greenhouse stock is available;
c) investigate the history and commercial production of bulbs;
d) investigate special propagation problems (e.g., how to obtain a new schefflera plant).

8. Some Teaching Suggestions

a) A greenhouse or a good plant-propagation area is necessary for the teaching of this unit.
b) Potted plants maintained in the classroom can be used as a teaching aid.
c) Plants brought from home should be inspected carefully for pests.
d) The time needed for growing a crop will overlap with other units. For this reason it may be desirable to integrate this unit with other units in the course that deal with plant growth.
e) Many tree seeds can be collected in late fall, scarified in sharp sand in baby-food jars, and placed in a refrigerator to overcome the dormancy period.
f) In winter, apple branches that are put in water for a few days before they are needed will be in good condition for slippage of bark for grafting demonstrations.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 2

Forestry II

Time: 15 hours

Forests can be treated as a plant crop that requires managing, just like horticultural and agricultural crops. Moreover, forests are one of the main sources of Ontario's and Canada's wealth, providing thousands of jobs. At the same time, our forests are threatened by fires, pests, pollution, and a lack of reforestation. This unit will introduce students to some basics of silviculture and forest management.

This unit may be divided into topics such as the following:

- Silviculture
- The improvement of species
- Forest management
- The protection of forests from fire and pests
- Northern and southern forest soils
- The value of forests

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that forests are one of Ontario's principal natural resources, providing thousands of jobs, as well as ecological benefits and opportunities for recreation;
b) a concern that ecosystems may be seriously damaged by the harvesting of trees (3e);
c) an appreciation that matching the specific requirements of tree species to the environmental conditions of the growing area is necessary for the successful regeneration of forests (2a).

Skills. Students will have the opportunity to develop skill in:

a) inspecting and comparing the characteristics of various species of trees (2a);
b) investigating the life history of a major forest pest (2c);
c) testing mineral soil in a forest for principal factors such as pH, nutrient content, and organic matter (2d);
d) identifying wood samples and tree twigs (2f);
e) experimenting to show the effect of acids on soils (2b);
f) measuring the quantity of harvestable timber in a forested area (2g).

Knowledge. Students will be expected to:

a) list the basic requirements of at least four tree species (2a);
b) describe some biotic and abiotic factors in forest ecosystems and relate these to forest succession (2d);
c) compare the usual results of monoculture with those resulting from the mixing of plant species;
d) explain the propagation of breeding stock by various techniques, including microculture;
e) explain methods of improving forest trees through selection and breeding;
f) briefly describe common forest-management practices, such as improvement cutting, selective cutting, clearing, clipping, pruning, timber cruising, and mensuration (2g);
g) explain methods of preventing and controlling forest fires;
h) describe a major forest pest, the damage it causes, and the means of controlling it (2c);
i) describe some of the major effects of fire and pests on forest succession;
j) describe the effects of harvesting methods such as clear cutting and shelter-wood cutting on forest succession;
k) describe the effect of acid deposition on forests and identify the parts of Ontario that are affected (2b, 2d);
l) describe the identifying characteristics of the twig and wood of selected important forest trees, such as white spruce, white pine, and sugar maple (2f);
m) list the ecological importance of forests in terms of their effects on factors such as soil and water, climate, wildlife, the production of oxygen, and pollution abatement (2h).

2. Student Activities

Students are to:

- *a) compare the characteristics of several species of trees and indicate where the necessary growth conditions for each species may be found (6a, 8a, 8b);
- *b) design and conduct an experiment to show the effect of acid on soils;
- *c) outline the life history of a commercially important forest pest and collect samples of the results of the pest (6a, 8a, 8b);
- *d) analyse forest duff and forest mineral soil for pH, organic matter, and principal nutrients (6a, 8a, 8d);
- e) record the effect of a tree on either the amount of rain that reaches the ground below it or the accumulation of snow beneath it (8b);
- *f) observe and identify various wood samples or twigs (8a, 8c);
- g) practise a method used to measure the harvestable timber in an area (6a, 8a, 8e);
- h) observe a forested area and evaluate its usefulness (6a, 8a).

3. Applications

a) The shape of some conifer species in the garden can be changed by clipping.
b) A campfire should be built on mineral soil rather than a forest duff to prevent it from spreading.
c) A forest can be harvested so as to allow natural reseeding.
d) Trees planted on a steep bank help prevent erosion.
e) Trees and shrubs can be planted to provide a habitat for birds and other animals.

4. Societal Implications

a) A planned reforestation program is necessary to avoid shortages of lumber in Ontario and Canada.
b) Lumber companies, conservationists, and wilderness enthusiasts often have different views regarding the use of forested areas.
c) Pesticide spraying to control forest pests may harm beneficial organisms and cause human health problems.
d) Acid deposition can have a negative effect on the forest industry.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) comparison charts and science notes;
b) projects and assignments.

6. Safety Considerations

a) Students should be cautioned that some plants in the forest undergrowth may be poisonous (e.g., poison ivy).
b) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) identify trees, using different dichotomous keys;
b) conduct a field study of different forest successions;
c) evaluate and compare several forested areas.

8. Some Teaching Suggestions

a) A field trip to forested areas is highly recommended to enhance this unit.
b) The school grounds can be used for several of the student activities.
c) Samples of wood can often be obtained from the school woodworking shop.
d) Samples of forest duff and mineral soil need to be collected prior to the start of the unit if students cannot do this activity in the field.
e) Forest mensuration and management techniques should be included as activities in this unit, particularly for students who have not performed these activities in Grade 10.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 3

Agricultural Crop Science II

Time: 15 hours

In order to obtain a maximum yield from a field and at the same time maintain the fertility of the soil, farmers must understand the requirements of crop plants and the effects of climate and soil conditions on their growth. This unit explores further the needs of various crops and the management practices used for optimum growth.

This unit may be divided into topics such as the following:

- Plant requirements and growth
- Preparation of a seedbed
- Planting methods
- Weed control
- Harvesting
- Storage
- Agricultural crops and the economy
- Marketing
- Farm management for field crops
- The processing of field crops

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the delicate nature of crop growth;
b) a curiosity about the planning that is necessary to produce food (3a, 4a);
c) an appreciation for the influence of technical advances on agricultural production (3b);
d) an appreciation of the importance of agricultural crops to the economy (3c, 4a-4c).

Skills. Students will have the opportunity to develop skill in:

a) relating the needs of various crops to the design of specific farm equipment (2a-2c);
b) planning a crop system so as to maximize the crop yield (2g);
c) predicting crop yields, using information on the climate and soil of the region (2g).

Knowledge. Students will be expected to:

a) describe the growth pattern of selected field crops, such as wheat, corn, soybeans, barley, and alfalfa (2d);
b) describe the steps in preparing seedbeds for most field crops, for example, tilling, soil testing, fertilizing, and applying pesticides (2c);
c) explain common planting methods (e.g., spacing, crop rotation, non-tillage seeding);
d) describe the methods for harvesting at least four crops;
e) describe how four field crops are stored (2e, 2f);
f) investigate common marketing practices for field crops (2f);
g) list the pests that are most troublesome to common crops and name the usual control measures (2c);
h) describe how several common pesticides function (2c);
i) briefly describe how some pests may develop resistance to pesticides (2c);
j) describe the advantages and disadvantages of both crop rotation and monoculture for agricultural crops (2g);
k) describe briefly the scientific basis of plant competition and the agricultural practices that are used as a result of this knowledge.

2. Student Activities

Students are to:

*a) observe and describe various types of tillage equipment, such as mouldboard ploughs, chisel ploughs, ridge tillers, cultivators, discs, and harrows (8c);
*b) observe various planting devices and describe how they are used for field crops such as wheat, corn, soybeans, and alfalfa (8a, 8c);
c) examine and describe the devices used to apply fertilizer and pesticides to field crops, for example, a seed-drill box, bulk spreaders, and anhydrous applicators (6a, 8a, 8c);
d) plant seeds of selected field crops and observe their growth when various amounts of fertilizer are applied (6a, 6b, 8d);
e) observe and describe the storage of field-crop produce in elevators, bulk tanks, cribs, silos, and dry bins (8a);
f) take a tour of the places involved in marketing a crop from the field to the grocery store, including wholesalers, cold-storage buildings, food terminals, and markets (6a, 6b, 8a);

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*See the subsection entitled "Student Activities" on page 5.

*g) plan a crop system for five years for an Ontario farm, considering factors such as crop rotation, market trends, available resources, type of soil, and available heat units (8a-8c, 8e).

3. Applications

a) Plant breeders must cope with many problems when developing new varieties (e.g., self-pollination, susceptibility to disease, climatic extremes).
b) The design of farm equipment is based on the physical properties of plants and their seeds.
c) Feed mills, flour mills, and fertilizer plants depend for their existence on the production of field crops.

4. Societal Implications

a) The type of farm found in an area is partly determined by the local topography. The farm output is a determining factor in the wealth of the local economy.
b) The regional food-processing industry depends on the productivity of local farms.
c) The export of Canadian produce increases the demand for goods and services in agricultural districts and thereby adds to the prosperity of the whole society.
d) The loss of farmland to urban sprawl is a problem in some areas of Ontario.
e) The use of some pesticides may create problems in the ecosystem of an area.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit will be based on students':

a) ability to identify equipment used for various crops;
b) ability to plant and grow field crops;
c) oral and written reports of field and laboratory work.

6. Safety Considerations

a) Students should wash their hands after working with soil, fertilizers, pesticides, or treated seeds.
b) Students should be asked to report to the teacher any allergies they have to the plants used in this unit.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) investigate the effect of large food-processing companies on agriculture in Canada;
b) write a report on how farms may operate in the future.

8. Some Teaching Suggestions

a) A visit to locations such as a local feed mill, fertilizer plant, farm-machinery dealer, or farm would be beneficial in conjunction with this unit.
b) A local representative of the Ministry of Agriculture and Food or a farmer can be invited to speak to students.
c) A visit to a spring or fall fair or the Royal Agricultural Winter Fair would add interest to the unit.
d) Students should handle some seeds and try growing them on their own.
e) Students should, if possible, observe fields of the crops being studied. For this reason, it would be best to teach this unit in the spring or fall.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 4

Landscaping I

Time: 15 hours

This unit should help students to recognize the beauty of design in nature as well as the ways in which the basics of good design can be applied to their own work or hobbies. It may help them to beautify their home properties, to compose satisfying scenes in photography, and, in some cases, to recognize their own talent in design.

This unit may be divided into topics such as the following:

- Reasons for landscaping
- Elements of landscape design
- Assessment of a site
- Mechanics of design
- Design styles
- Selection of plant material
- Career opportunities

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the elements of good design (3a, 3c);
b) an appreciation that much good design surrounds us in nature and in human compositions (3a).

Skills. Students will have the opportunity to develop skill in:

a) assessing a residential site according to neighbourhood, topography, orientation, drainage, and facilities such as water lines and hydro poles (2a);
b) planning the areas of use for a property (2b);
c) sketching, using landscaping symbols (2c);
d) designing simple landscapes (2d, 2e).

Knowledge. Students will be expected to:

a) describe briefly the characteristics of good and poor landscaping;
b) list the advantages of good landscaping to the property owner;
c) describe several materials used in landscaping, including plant materials, construction materials, soil, and water;
d) describe briefly several elements of design used in landscaping, including colour, texture, balance, contrast, harmony, and repetition;
e) identify some basic styles of architecture and landscape architecture;
f) state the characteristics to be considered in the analysis of a site, including character of the neighbourhood, topography, drainage, orientation, and soil;
g) list the possible wishes of the property owner and his/her family for the landscaping of a property;
h) describe which particular landscaping features are practical for a given site and indicate suitable locations (2b);
i) describe the methods of establishing suitable scales for plans;
j) describe briefly past and current landscape design cycles, indicating ways in which buildings and gardens complement each other;
k) describe the use of symmetrical or asymmetrical balance and regular or flowing lines in formal or stylized design;
l) describe the use of axes in formal designs to locate focal points of interest and the use of repetition of shapes in stylized design;
m) give examples of the usual kinds of plant materials used in landscape design and list the criteria for choosing plants, including hardiness and time of bloom (2g);
n) identify occupational opportunities available in landscaping.

2. Student Activities

Students are to:

*a) analyse a home site or the school grounds and adjacent properties in terms of their potential for landscaping (8b, 8d);
*b) plan a property to show division into areas of use (8b);
*c) practise drawing landscaping symbols (8e);
*d) make one formal landscape plan drawn to scale (8a, 8e);
e) produce one informal landscape plan drawn to scale (8a, 8e);
f) produce one stylized landscape plan drawn to scale (8a, 8e);
g) name suitable plants for one of the landscape plans (8c, 8f).

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) An understanding of the principles of good design makes it possible to appreciate a well-designed garden or to recognize a well-composed scene for photography.
b) The ability to recognize basic styles of architecture leads to a greater appreciation of the surroundings.
c) An understanding of landscape design helps a person to assess a site for a new house, design a patio, choose foundation evergreens at a nursery, and create a point of interest in a garden.
d) Practicality and good design can coexist with many benefits.

4. Societal Implication

Good landscape designing can make the surroundings much more attractive and pleasant.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) ability to plan the areas of use for a property;
b) ability to sketch and use landscape symbols.

6. Safety Considerations

a) If a field trip is included with this unit, students should be asked to report possible allergies to plant materials to the teacher.
b) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) practise designing stylized gardens;
b) investigate other elements of design, such as tone and movement;
c) examine a particular style of architecture in greater detail;
d) name suitable plants for various landscape plans.

8. Some Teaching Suggestions

a) Throughout this unit, visual examples should be provided whenever possible. In addition to visiting actual sites, students should be shown coloured slides, overhead projectuals, and books with appropriate illustrations.
b) The possibility that many students may have their own property to landscape in the future can be a motivating focus for this unit.
c) Students should select plants that are appropriate in terms of size, colour, sun-shade tolerance, their effects on other plants and animals, time of bloom, and hardiness.
d) A landscape architect can speak to the class about a particular design problem.
e) Designs should be done on standard notebook-sized sheets. Elaborate designs on drafting paper are not necessary.
f) Old nursery catalogues are good sources of names for suitable plants.

Optional Unit 5

Garden Maintenance

Time: 15 hours

This unit focuses on the basic knowledge and skills required to maintain a garden. Students may find the knowledge and skills they acquire useful in obtaining summer or permanent employment, as well as in caring for a personal garden sometime in the future.

This unit may be divided into topics such as the following:

- Garden tools
- Lawn maintenance and rehabilitation
- Shrub- and evergreen-bed maintenance
- Flower-bed maintenance
- Tree care
- Planting procedures
- Analysing job tasks
- Keeping a work-time record

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that gardening requires the application of certain knowledge, techniques, and skills (2a, 2b);
b) a commitment to good preplanning as a requirement for the successful completion of gardening tasks (2g);
c) a commitment to replace energy-intensive processes where appropriate to conserve energy (2f).

Skills. Students will have the opportunity to develop skill in:

a) using and maintaining common garden tools and equipment (2a, 2e, 2h);
b) applying chemical fertilizers, water, and mulches (2b, 2d);
c) inspecting gardens and determining the work that is required (2g);
d) maintaining a compost bin (2f).

Knowledge. Students will be expected to:

a) explain the proper procedure for the use of the tools and equipment required in the unit (2a);
b) explain the basic principles involved in the tasks given, such as pruning, mulching, and cleaning (2d, 2e, 2h);
c) describe the amounts of water, fertilizers, or mulches to use on a particular garden (2b-2d);
d) outline the necessary maintenance required for a lawn, planting bed, flower bed, or tree (2g);
e) describe the steps necessary to rehabilitate a lawn area;
f) describe the necessary care and maintenance of garden tools and equipment (2h);
g) list the steps in planting various kinds of plant material;
h) develop a work sheet based on an analysis of the garden area (2g);
i) calculate the time per task from a work-time record;
j) outline a means of biological control of insects (e.g., the use of ladybird beetles to control aphids).

2. Student Activities

Students are to:

*a) use garden tools such as trowels, spades, and rakes to prepare and maintain a garden (6a, 8b);
*b) apply chemical fertilizers to lawns, trees, or planting beds (6b);
c) develop and carry out a plan to irrigate lawns or plantings;
d) apply mulching materials to a planting bed;
e) prune woody plant material (6a);
*f) clean and tidy planting areas and maintain a compost bin;
*g) inspect gardens, analyse the work that is required, and prepare a plan to accomplish this work (8c);
*h) clean and maintain garden tools (6c).

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) A lawn can be watered in the early spring to remove accumulated salts from the driveway area.
b) Shade trees can be rejuvenated by sufficient and proper use of fertilizers.
c) The appearance of a property can be greatly enhanced by properly tended lawns and plantings.
d) Old garden tools and equipment can be reclaimed by proper cleaning and maintenance.
e) The recycling of plant parts through composting can reduce the need for energy-intensive fertilizer.

4. Societal Implications

a) Properly tended public grounds make the surroundings much more attractive and pleasant.
b) The proper planning and maintenance of lawns and gardens helps prevent the erosion of properties.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) ability to perform outdoor work;
b) ability to work with the teacher and other students on tasks and plans.

6. Safety Considerations

a) Students should exercise care when using garden tools, especially those with cutting edges or blades.
b) Students should wash their hands thoroughly after using chemical fertilizers.
c) Students must exercise care when sharpening tools.
d) Students must exercise care when using machinery with moving parts (e.g., they should wear safety boots when operating a lawn mower).
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) develop and maintain special school areas for the culture of fruit and vegetables or for field-crop test plots;
b) develop new planting areas to improve the appearance of the school grounds;
c) prepare a specialty area for planting by double digging.

8. Some Teaching Suggestions

a) This unit should not be considered unless it can be made quite practical. The co-operation of the school administration and custodial staff is essential. Garden tools and equipment, together with adequate storage space, are required.
b) Students should be instructed in the appropriate use of tools or equipment before working on their own.
c) Task-assignment sheets for individuals or groups should be prepared before students undertake the activities. Tasks must be reasonable in difficulty and length.
d) This unit should be scheduled at times of the school year that are appropriate for the various tasks to be undertaken.

Optional Unit 6

Noise Pollution

Time: 15 hours

Modern society, with its large number of motor vehicles, electronic equipment, and electric appliances, creates a great deal of noise. Noise pollution ranges in its effects from irritation to psychological and physiological damage. This unit will make students aware of the problem and provide them with the basic knowledge they would need to take part in noise-abatement programs.

This unit may be divided into topics such as the following:

- The characteristics of sound
- Measuring noise
- Noise in the community
- Effects of noise
- Reducing noise
- Noise and the law

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a respect for other people's right to silence and their opinions as to whether a sound is pleasant or unpleasant (2c);
b) an appreciation for their own contribution to noise pollution;
c) a commitment to take part in local programs intended to reduce noise (3a, 3b);
d) an appreciation and respect for antinoise laws and regulations.

Skills. Students will have the opportunity to develop skill in:

a) conducting a survey of people's attitudes to noise (2c, 2f);
b) using a sound-level meter (2a, 2f);
c) designing a controlled experiment to study the effect of noise on mental activity (2d).

Knowledge. Students will be expected to:

a) identify various kinds of sounds and indicate their sources;
b) state the main characteristics of sound;
c) develop a definition for noise;
d) define the unit decibel and describe when it is used (2a);
e) describe the decibel scale for measuring sound levels;
f) list the sources of noise in the local environment;
g) explain the social, physiological, and psychological effects of noise pollution (4a);
h) describe ways of reducing noise with building materials, trees, and plants (3b);
i) relate noise to land use and the value of houses;
j) describe briefly the federal, provincial, and municipal laws concerning noise;
k) describe how laws can be used to decrease noise.

2. Student Activities

Students are to:

*a) measure the sound levels over a period of time during various activities in classrooms and plot the number of decibels for each activity on a graph (6a, 8a);
b) study the level of noise in such locations as the school, home, various workplaces, or nearby streets (6b);
*c) conduct a survey of people's attitudes to noise in the community; determine whether any annoyance is related to the loudness, pitch, or source of the noise; and compare the findings with complaints made by citizens to the local authorities (8b, 8c);

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*See the subsection entitled "Student Activities" on page 5.

*d) create quiet and noisy environments and test the performance of students on a complicated task, making comparisons of the results according to age, group, sex, and type of sound (6a, 8c);
e) obtain an audiometer, test students in a class or school, and attempt to relate the results to the noisiness of students' leisure activities;
f) measure the noise levels of various activities that people choose to expose themselves to, for example, concerts, sports events, and listening to stereos (6a);
g) investigate the effect of loud noises on blood pressure and heart rate (6a).

3. Applications

a) Trees can be used to help block and absorb the noise from expressways, airports, and noisy industries.
b) Building materials can be chosen to create a quieter environment.
c) Individuals should choose quiet places in which to study or relax.
d) Hearing loss can be reduced through the avoidance of extremely noisy activities and surroundings.

4. Societal Implications

a) The noise in the environment can make people sick and distract them from their work.
b) Wildlife is adversely affected by noise.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, surveys, and field studies;
b) assignments, projects, and records of experiments.

6. Safety Considerations

a) Students must use ear protectors when measuring sound levels in excess of 85 dB.
b) Students should be accompanied by a teacher if measuring traffic noise levels.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) compare the soundproofing effect of various materials;
b) visit the local society for the hearing-impaired to investigate the newest hearing-aid technology;
c) investigate why stores and banks play music.

8. Some Teaching Suggestions

a) If a sound meter is not available, students can use a tape recorder and note the levels registered on the intensity gauge.
b) The loudness of a number of sounds recorded on a tape at measured volumes can be rated by various people. The answers can be compared according to the age and sex of the respondents.
c) Participation in an experiment or a survey should be voluntary.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 7

Outdoor Skills

Time: 15 hours

The enjoyment of camping in the out-of-doors is partly derived from the satisfaction of coping with the adaptations necessary for survival in an unfamiliar and unpredictable environment. As the everyday world becomes less physically demanding, more and more people are seeking the challenge of outdoor activities. This unit is intended to teach students how to enjoy the outdoors by making common-sense preparations for outdoor activities, especially in the wilderness. It also provides insight into the preparation that must be made by persons who work outdoors in the vast unpopulated areas of Canada.

This unit may be divided into topics such as the following:

- Planning a trip
- Safety and first aid
- Protecting the environment
- Food, water, and cooking
- Clothing, footwear, and sleeping gear
- Tents, heaters, and emergency shelters
- Packing
- Navigation
- Maintaining body temperature

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a commitment to being prepared when venturing into the wilderness (3a, 3b);
b) a commitment to leaving a copy of one's travel plans with a responsible person;
c) a concern for the sensitivity of the environment to human activity (4b, 4c).

Skills. Students will have the opportunity to develop skill in:

a) following appropriate safety precautions on an outdoor excursion (2h, 2i);
b) predicting changes in the weather (2i);
c) disposing of human wastes (2i);
d) choosing and preparing food suitable for an excursion (2d, 2i);
e) building a safe fire for heating and cooking (2e, 2i);
f) cooking simple foods over a fire (2e, 2i);
g) finding and sterilizing water for drinking (2i);
h) choosing the proper clothing for outdoor activities (2g, 2i);
i) building an emergency shelter (2f);
j) choosing and packing a backpack or canoe pack (2b, 2i);
k) finding their way by means of maps, compasses, the sun, stars, and vegetation (2c, 2i);
l) observing their natural surroundings and identifying the specific biotic and abiotic features (2i);
m) choosing suitable equipment for outdoor activities (2i);
n) operating and maintaining outdoor equipment (2i).

Knowledge. Students will be expected to:

a) describe safety practices, methods of rescue, and first aid for trips over land, ice, and water;
b) describe ways of protecting themselves from animals, insects, and poisonous plants;
c) state the amount of water needed by the body and list outdoor sources of drinking water and ways of treating it;
d) describe methods of packaging and storing food for outings and describe some edible wild plants (2d);
e) describe the insulating qualities of different materials and the design of clothing and footwear for the outdoors (2g);
f) describe thermal regulation in the body and state the causes of hyperthermia and hypothermia;
g) describe the physical demands of various outdoor activities.

2. Student Activities

Students are to:

a) read an article or a booklet on an outdoor activity, such as backpacking or hiking, and develop a report for the class;
b) compare the design, material, fit, and capacity of different backpacks;
c) use a compass outdoors to take bearings and to follow bearings from a map (6a, 6c, 8c);
d) compare different methods of packaging food for transport (8g);
e) select and use a portable stove or build a fire and cook simple foods (6a, 6b, 6d, 8a, 8f);
f) compare tents of different material and design and build an emergency shelter (6b, 8a, 8d);
g) compare the design and properties of outdoor clothing and footwear;
h) make a basic survival kit (8a);
*i) plan and carry out a backpacking trip or canoe trip.

3. Applications

a) People who are familiar with survival skills are more comfortable in the out-of-doors.
b) A knowledge of outdoor skills gives a person a better chance of surviving an emergency in the wilderness.
c) A knowledge of outdoor skills may lead to outdoor work or hobbies.
d) People who have studied outdoor equipment will be better able to choose equipment for themselves.

4. Societal Implications

a) The decrease of physical challenges and danger in everyday life makes some people look for those things in the wilderness.
b) The growing popularity of wilderness activities is endangering many wilderness areas.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) records and notes;
b) ability to demonstrate outdoor skills;
c) ability to plan an outdoor excursion.

6. Safety Considerations

a) Appropriate safety procedures must be established and followed on field trips.
b) Saws, stoves, and other outdoor equipment must be used in an approved manner.
c) A well-equipped first-aid kit must be taken on any outdoor excursion.
d) Fires must not be built outdoors when the risk of forest fires is high.
e) Students should be warned about poisonous plants and dangerous insects and other animals in the area of the outdoor study.
f) Students should be asked to report to the teacher any allergies or health problems before going on a field trip.
g) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) make a list of the food and clothing required for a specific type of excursion;
b) investigate the environmental dangers, such as poison ivy, in a specific district;
c) plan a trip, using a map and compass;
d) compare the efficiency of various cooking stoves and different kinds of firewood;
e) compare the insulating qualities of sleeping bags and clothing with different kinds of filling;
f) test the effectiveness of various insect repellants.

8. Some Teaching Suggestions

a) Safety should be emphasized in all activities in this unit. Prior to taking an outdoor excursion, students must acquire the necessary skills.
b) This unit can be integrated with other units in the course where field studies are required.
c) An orienteering trail can be set up to be used for compass work.
d) Individual survival kits can be constructed for use on excursions.
e) An "Outdoors Club" can be organized to take weekend trips.
f) The "out of camp and leave no trace" philosophy should be emphasized.
g) Pemmican and bannock can be made in the laboratory.
h) A long excursion should be preceded by one or two local outings of short duration.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 8

Locally Designed Unit

Time: 15 hours

This unit is the same for the Grade 11 general-level environmental science course as optional unit 6, "Locally Designed Unit", is for the Grade 10 general-level course (see page 30). A different set of topics from those selected in the previous grade should, of course, be chosen for this course.

Environmental Science, Grade 12, General Level
(SEN4G)

Core Units

Soils: An Important Resource
Air Quality and Waste Management
Pests and Pest Control

(50 hours)

Optional Units

Horticulture III
Comparative Ecosystems
Plant and Animal Pathology
Applied Genetics
Landscaping II
Agribusiness
Locally Designed Units (2)

(60 hours)

Core Unit 1

Soils: An Important Resource

Time: 15 hours

The growth of the world's population and the resultant increasing demand for food and natural fibres have increased the need for fertile soil. Fertile soil, the basis for the production of most foods, livestock, feed, timber, and natural fibres, is an important natural resource. Productivity in some countries has declined because the soil has not been maintained. This unit concentrates on desirable soil-management practices that result in the conservation of soil.

This unit may be divided into topics such as the following:

- Relationships between plants and soil
- The nature of soil
- Classes of agricultural land
- Maintaining and restoring the fertility of the soil

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that the food-producing system is part of a fragile ecosystem (4a);
b) an appreciation that we are dependent on soil (4a);
c) a concern for careful planning in the management of soil (3c, 4a).

Skills. Students will have the opportunity to develop skill in:

a) selecting representative soil samples from an area (2f);
b) measuring the amount and availability of some elements in the soil (2f, 2g);
c) observing and identifying deficiency symptoms in plants (2h);
d) interpreting the results of soil tests (2f, 2g);
e) classifying agricultural land (2e).

Knowledge. Students will be expected to:

a) list the nutrients required by plants that grow in soil (2h);
b) describe the relationship between soil and nutrient absorption by plants;
c) describe soil weathering processes (2b);
d) describe the nature of good agricultural land (2e);
e) list the seven main land-use classes of agricultural land (2e);
f) explain various practices, such as overgrazing and monoculture, that result in the loss of desirable properties in the soil;
g) describe the practices entailed in building and maintaining topsoil, as well as general soil-conservation techniques;
h) describe fertilizer types, uses, and analysis (2i);
i) describe the relationship between plants and soil microbes (2d).

2. Student Activities

Students are to:

a) compare the water-holding capacities, porosities, or bulk densities of different types of soil (6a, 8e);
b) survey the local district for examples of weathering;
c) compare the rate of chemical leaching in soils, for example, the release of phosphorus by weak acid from sand and clay (6b);
d) examine the roots of legumes such as soybeans for indications of the presence of rhizobium bacteria and the roots of various plants such as pine trees for mycorrhizal fungi (6a, 8d);
*e) classify one or more local parcels of land according to the seven land-use-capability classes of agricultural land;
*f) demonstrate techniques for sampling soil and testing soil samples for levels of common soil nutrients and pH (6a, 8a, 8c);

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*See the subsection entitled "Student Activities" on page 5.

g) measure the amount of phosphorus in clay and sandy soils and compare the amount of phosphorus available in soils with different pH levels (6a, 8a, 8c);
*h) culture plants such as corn in pots of clean quartz sand and observe the effects of moistening the sand with nutrient solutions that are deficient in specific elements (6b, 8b);
i) compare the solubilities of various fertilizers (6a);
j) investigate the effect of limestone or magnesium sulphate on the pH of soil (6a, 6b).

3. Applications

a) A knowledge of land classifications can be helpful to individuals or public officials who are deciding what land to buy or how to use it.
b) The chemical analysis of soil can prevent an excessive application of fertilizers, lessen the concentration of nutrients in run-off, and save money.
c) A knowledge of soil characteristics enables a gardener or farmer to recognize the need to replace nutrients that have been removed from the soil, to remedy deficiencies, to change the pH of soil, and to apply fertilizers so as to obtain the maximum benefit from the nutrients.

4. Societal Implications

a) Soil is the basis for most food production. Its careful management is necessary if future generations are to have enough food.
b) Land suitable for agriculture is often used for residential, commercial, or industrial purposes.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory techniques and reports;
b) notes, projects, and assignments.

6. Safety Considerations

a) Students should wash their hands after working with soil fertilizers and other chemicals.
b) Students should be informed that some of the plants and chemicals used in this unit may cause allergic reactions.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) analyse a sample of soil from a home or school garden and interpret the results;
b) propagate plants, such as tomato, cucumber, or lettuce, without soil – either hydroponically or in a soilless medium such as perlite;
c) investigate and report on the soil requirements for a specific crop (e.g., blueberries, sod).

8. Some Teaching Suggestions

a) Care and cleanliness are very important if accurate results are to be obtained when soils are tested for nutrient levels.
b) In planning this unit, teachers must consider that it may take six to eight weeks to grow plants from seed in order to determine nutrient deficiencies.
c) Soil samples should be collected before the ground freezes and should be stored in airtight containers in a cool place.
d) Roots with rhizobium bacteria and mycorrhizal fungi can be stored in cool moist containers for later examination.
e) Soil-management techniques and the value of soil to society should be stressed throughout the unit.

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*See the subsection entitled "Student Activities" on page 5.

Core Unit 2

Air Quality and Waste Management

Time: 20 hours

Pollution of the environment is one of the most serious problems facing society today. This unit will give students a basic understanding of the causes of air and land pollution, the measures that are used to reduce pollution, and the role of the individual in causing and preventing pollution.

This unit may be divided into topics such as the following:

- The composition of dry, clean air
- Solid and liquid particulate matter in air
- Gaseous pollutants in air
- Air quality and plant life
- Domestic, industrial, and agricultural wastes
- Disposal of solid wastes
- Sewage treatment
- Recycling and reusing solid waste

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the importance of the quality of the air we breathe (4a, 4d);
b) a curiosity about their part in polluting the air and land, for example, by littering and smoking (2h);
c) a commitment to adopt habits that will result in a reduction of solid wastes (2h).

Skills. Students will develop skill in:

a) observing and comparing the effects of air pollutants on plants (2d);
b) using the microscope to examine airborne particles (2a);
c) inferring the effect of temperature on the decomposition of sewage by bacteria (2f).

Knowledge. Students will be expected to:

a) explain the importance of oxygen, nitrogen, carbon dioxide, and water vapour to plants and animals;
b) list the most abundant airborne particulates, both natural and human-made, and their sources;
c) state the major effects of pollutants on human health, on vegetation, on both natural and synthetic fibres, and on other materials (2d, 2i);
d) list the sources and effects of the main gaseous pollutants, for example, photochemical oxidants, sulphur oxides, hydrocarbons, nitrogen oxides, carbon dioxide, carbon monoxide, ozone, and fluoride (2b, 2d, 2i, 8f);
e) explain that incomplete combustion of fossil fuels produces many harmful solid and gaseous pollutants (2c);
f) describe injuries from air pollutants on plants, such as the browning of bean plants by ozone, and explain why lichens are indicators of air quality (2d, 2i);
g) compare domestic wastes, both solid and liquid, to industrial and agricultural wastes (2h);
h) explain the various methods of disposing of solid wastes and outline the problems involved in locating suitable dump sites for various types of waste (2g, 2h);
i) explain the methods and stages of domestic sewage treatment, including individual septic systems (2f, 2g);
j) describe how many solid wastes can be reused or recycled (2h);
k) state the chemical name for two or three common pollutants, for example, phosphates and nitrates, and describe their effects on the environment (2e, 8e).

2. Student Activities

Students are to:

*a) examine particulate matter under the microscope and perform an experiment to compare the amount of solid particle fallout in different places (8a);
b) compare the carbon dioxide concentration in samples of air taken from at least three sources and bubble the same volume from each source, at the same rate, through a limewater solution; sources could include exhaled air, air from the laboratory, or car exhaust fumes (8g);

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*See the subsection entitled "Student Activities" on page 5.

c) demonstrate the complete and incomplete combustion of fuels, using a fuel such as acetylene gas (6e, 8b);
*d) examine the effects of the exhaust fumes from a car on plants (6a);
e) demonstrate the precipitation of phosphates during the tertiary treatment of sewage by dissolving a few grams of sodium phosphate in water and adding limewater (6b-6d);
*f) investigate the effect of temperature on the fermentation of yeast (8c);
g) visit a sewage-treatment plant or landfill site and write a report on how it functions;
h) classify the garbage produced over a few days in the home, suggest ways of reducing the amount of solid waste, and investigate local recycling facilities.

3. Applications

a) Ozone and oxides of nitrogen cause dyed fabrics to fade.
b) Ozone causes rubber, such as that in windshield-wiper blades, to crack.
c) Fluorides endanger human health, soften the bones of cattle, and damage citrus trees.
d) Fuels burned without an adequate air supply add pollution to the environment.
e) Masonry and metal structures are damaged by airborne pollutants dissolved in precipitation (e.g., sulphur dioxide and nitrogen oxide in solution).

4. Societal Implications

a) An increasing awareness of the dangers of second-hand smoke is intensifying the struggle by non-smokers for the right to clean air.
b) Solid wastes can be reduced by increasing the number of recycling facilities.
c) Household garbage can be reduced by composting leaves and biodegradable garbage at home.
d) Air-quality standards are necessary to protect workers who are exposed to airborne substances such as sulphur dioxide or asbestos.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work;
b) assignments, projects, and records of experiments.

6. Safety Considerations

a) A fume hood must be used for all experiments with sulphur dioxide and nitrogen oxides.
b) All chemicals must be labelled properly.
c) Students should wash their hands after working with chemicals.
d) Students should be asked to report to the teacher any allergies to the plants or chemicals used in this unit.
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) investigate the treatment of municipal drinking water;
b) demonstrate a temperature inversion;
c) determine the mass of particulate matter in a unit volume of air;
d) determine the organic and inorganic composition of airborne matter.

8. Some Teaching Suggestions

a) To observe the fall-out of solid particles, students can place white pieces of paper or vaseline-covered microscope slides in a horizontal position in the area to be investigated.
b) Small lumps of calcium carbide can be used to produce acetylene gas.
c) The fermentation of yeast can be related to the process of bacterial digestion in the treatment of sewage sludge.
d) Experiments that study the effects of sulphur dioxide and nitrogen oxide should be demonstrated in a fume hood.
e) Pollutants that are important locally should be discussed.
f) Students can discuss various sources of chemicals that cause acid deposition. They should also consider the politics and economics of the control of acid deposition.

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*See the subsection entitled "Student Activities" on page 5.

Core Unit 3

Pests and Pest Control

Time: 15 hours

Since the Second World War there has been an enormous increase in the production and use of chemical pesticides. On the one hand, these products have benefited society by killing insects that carry diseases such as encephalitis and by reducing the losses of crops to various pests. On the other hand, pesticides can cause damage to the environment and to human health, and their use has led to controversy and lawsuits. This unit introduces students to the pesticide issue and considers a variety of methods of pest control.

This unit may be divided into topics such as the following:

- Common pests
- Common pesticides
- The nature of pesticides
- Benefits of pesticides
- Dangers from pesticides
- Pesticides and the environment
- Non-chemical methods of control

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the importance of pesticides in maintaining human health and providing convenience (3d);
b) a concern for the danger of some pesticides to human health (4f);
c) objectivity concerning the place of pesticides in food production (3c, 4e, 4g);
d) a concern for the need to find and develop alternative methods of controlling pests (4a, 4f);
e) an appreciation for the environmental problems caused by pesticides (4g);
f) an appreciation that chemical pesticides are poisons and must be handled and stored carefully (3b).

Skills. Students will have the opportunity to develop skill in:

a) classifying pesticides according to various criteria (2d);
b) identifying pests and pest damage (2a);
c) observing the effect of a herbicide (2e).

Knowledge. Students will be expected to:

a) identify common insect pests and explain how pesticides help prevent human diseases (2a);
b) categorize the different kinds of pesticides: insecticides, herbicides, fungicides, rodenticides, algicides, and miticides (8e);
c) give examples of common pesticides (2d, 2i);
d) explain the various ways in which pesticides function;
e) describe how pests develop resistance to pesticides;
f) list possible damage that pesticides can cause to humans and the environment;
g) describe some non-chemical alternatives to chemical pesticides, such as natural predators, viruses, sterilization of pests, hormones, organic pesticides, diversity in forests, crop rotation, and companion planting (2b);
h) explain the meaning of the following terms in relation to pesticides: toxicity, non-selective, systemic, fumigant, repellent, integrated pest management (2b, 2d);
i) give examples of public controversy about the use of pesticides and explain the different points of view;
j) explain what is meant by *selectivity of pesticides;*
k) list the precautions for and describe the safe method of handling some common pesticides;
l) describe some of the controls exercised by government to ensure that the pesticides that are used are safe and that they are handled and used safely;
m) describe the bioaccumulation of pesticides.

2. Student Activities

Students are to:

*a) locate examples of pest damage by insects and identify the causes (8c);
b) visit a health-food store, an organic farm, a market garden, or a modern farm to examine pest-control methods (8a);
c) draw a food web for a lake or river and illustrate the possible movement of pesticides and other chemicals in an ecosystem (8a);

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*See the subsection entitled "Student Activities" on page 5.

*d) gather information from pesticide containers and draw up charts, showing the active ingredient, concentration, method of application, use, and toxicity of various pesticides (6b);
*e) apply the herbicide 2,4-D in various dilutions to plants, such as beans, wheat, and tomato and pea seedlings, to investigate its effects (6a-6c, 8b, 8e);
f) spray various kinds of plants with water, record the effect of the leaf texture on the retention of water, and experiment to determine how the addition of detergent or light oil affects the retention of water;
g) compare the effects of different algicides on algae growing in glass containers;
h) grow separate populations of aphids and ladybird beetles, transfer the beetles to plants with aphids, and keep track of the population of aphids;
i) investigate how spray calendars for fruits and vegetables are used to determine when applications of pesticides should be made.

3. Applications

a) The growth of algae in swimming pools and aquariums can be prevented by means of algicides.
b) Accidents that occur during the storing and use of pesticides can be avoided by following the directions on the containers.
c) The control of pests increases the production of food and improves its appearance.
d) Diseases carried by pests can be reduced if the pests are controlled.
e) The control of insects (e.g., spruce budworm) that damage trees would increase the supply of forest products.

4. Societal Implications

a) Harmful insects, including the mosquitoes that spread malaria and encephalitis, tend to become resistant over time to the pesticides that formerly controlled them.
b) Some pesticides that are banned in Canada are used in developing countries and may be returned to Canada as residues on the produce that is imported from those countries.
c) It takes several years and considerable capital to develop and test a new pesticide.
d) Bacterial insecticides such as *Bacillus thuringiensis* are sometimes used as alternatives to chemical insecticides.
e) The use of chemical pesticides in energy-intensive North America lowers the price of food by saving labour and reducing the loss of plants to pests.
f) The use of pesticides has created concern about their effects on human health.
g) The control of a specific insect population through the use of chemicals may affect birds and other natural predators.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work and reports;
b) notes, projects, and assignments.

6. Safety Considerations

a) All regulations regarding the use of pesticides must be followed, and proper safety equipment must be worn.
b) Students should wash their hands after handling and using pesticides.
c) The manufacturer's instructions concerning the precautions to be taken in handling pesticides must be followed.
d) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) draw up a fact sheet on a pest in the local area, including such information as means of identifying it, its benefits, the harm it causes, and the importance and methods of controlling it;
b) draw up a pest-control calendar for the home garden;
c) lay out test plots on the school grounds to test the effectiveness of one or more herbicides (e.g., 2,4-D).

8. Some Teaching Suggestions

a) Various viewpoints regarding the use of pesticides should be discussed.
b) Plants for the testing of herbicides should be started about two weeks ahead of the date of the planned application.
c) Examples of damage caused by pests should be collected and stored for future use (e.g., canker on plums and peaches, birch-leaf miner, birch borer, gall mites on maples).
d) Students can germinate seeds on agar to compare the growth of fungi on treated and untreated seeds.
e) A simple pump-spray bottle, such as those used for window cleaners, can be used to spray 2,4-D solution.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 1

Horticulture III

Time: 15 hours

The culture of many horticultural crops, such as greenhouse crops, requires the planned control of the various growth factors so that the plants will be ready when needed. This unit examines some of the management methods used to achieve this end.

This unit may be divided into topics such as the following:

- Light control in greenhouses
- Temperature control and energy conservation in greenhouses
- Air control in greenhouses
- Moisture control in greenhouses
- Fertility control in greenhouses
- Growing media
- Chemical regulators
- Greenhouse efficiency
- Business management

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the skills and knowledge needed to produce a successful greenhouse or garden crop (3e);
b) a curiosity about the usefulness of various horticultural practices (3d).

Skills. Students will have the opportunity to develop skill in:

a) experimenting with the effect of light intensity or day-length on plant growth (2a);
b) keeping a record of a greenhouse experiment (2a);
c) planning the layout of greenhouse benches or a workroom (2c);
d) growing a plant crop (2e);
e) cost accounting for the greenhouse crop grown (2f);
f) testing the pH and nutrient levels of various growing media (2h).

Knowledge. Students will be expected to:

a) list the common methods of providing greenhouse crops with auxiliary lighting and shading and of shortening their day-length and interrupting their night-length (2a);
b) recall various ways of heating greenhouses and name the fuels used (2b);
c) select practical ways of conserving energy in greenhouses (2b);
d) explain the need for stand-by electrical generators and warning systems in greenhouses (2b);
e) explain various methods of cooling greenhouses, regulating oxygen and carbon dioxide levels in greenhouses, watering greenhouse plants, regulating greenhouse humidity, and applying fertilizers to greenhouse crops;
f) describe the water requirements of various types of plants;
g) explain the effect on plant growth of nutrient deficiencies and surpluses, high salt concentrations, and high and low pH levels (2h);
h) describe the effects of common soil pollutants on plant growth;
i) categorize various fertilizers according to their use and the ratio of their nutrient content;
j) describe suitable fertilization rates and programs for various greenhouse crops;
k) describe commonly used soil and artificial mixes;
l) list and explain the use of various kinds of chemical plant regulators for such purposes as stem elongation and dwarfing;
m) describe the business operations of a commercial greenhouse (2f).

2. Student Activities

Students are to:

*a) experiment with the effect of light intensity or day-length on a plant crop (6a, 6b);
b) develop a scrapbook of greenhouse equipment or of horticultural equipment for field culture;

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*See the subsection entitled "Student Activities" on page 5.

*c) plan the layout for greenhouse benches or a workroom;
d) test the effects of a growth retardant on a crop (6a, 6b);
*e) grow a typical greenhouse plant crop to maturity (6a, 6b, 8a);
*f) calculate the per-unit cost of the plant crop grown (8c);
g) experiment with the effects of different fertilization levels on a plant crop (6a, 6b, 8d);
*h) test the pH and major nutrient levels of growing media for greenhouses (6a, 6b);
i) experiment with the effects of different amounts of water on a crop (6a, 6b).

3. Applications

a) Tender fruit trees can be planted on a slope to avoid frost damage to the blossoms.
b) Potted plants in the home should be well watered to avoid an accumulation of salts.
c) Greenhouse plants are watered early in the day to avoid high humidity as night approaches.
d) To grow a crop for profit requires attention to cultural requirements and economic principles.
e) House plants should be fertilized less often during the winter because of reduced light.
f) Lights must not be turned on where short-day plants are initiating flower buds.

4. Societal Implications

a) Greenhouse flower crops require intensive management so that flowers are available both during the off-seasons and at specific times of demand.
b) Greenhouses enable plants that are not native to Canada to be grown locally.
c) Horticultural operations employ many people in Canada.
d) Home greenhouses provide an enjoyable hobby for many people.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory and greenhouse work;
b) notes;
c) assignments and projects.

6. Safety Considerations

a) Students should be warned of possible allergic reactions to the plants and chemicals used in this unit.
b) Students should wash their hands after working with plants, soil, fertilizers, and other chemicals. Direct contact with fertilizers and chemicals must be avoided.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) study the discharge of ethylene gas by apples in storage and the defoliation of plants by the gas;
b) examine a current development in horticultural equipment.

8. Some Teaching Suggestions

a) A greenhouse or an appropriate growing area is essential for this unit.
b) To ensure the time necessary for growing a crop, this unit can be integrated with other units dealing with plant growth in this course.
c) Figures on the average fixed cost of operating a greenhouse can be obtained from texts on bedding plants and from the Ontario Ministry of Agriculture and Food.
d) A variety of soluble fertilizers with different analyses are useful in regulating fertility levels in crops.

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*See the subsection entitled "Student Activities" on page 5.

Optional Unit 2

Comparative Ecosystems

Time: 15 hours

This unit will help students understand the complexities of nearby ecosystems and the effects on them of human activities. It will also introduce students to the processes of analysis and assessment, which are used in environmental-impact studies when large-scale construction or changes in land use are planned.

This unit may be divided into topics such as the following:

- Biotic and abiotic factors
- Field study
- The influence of people on ecosystems

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that the processes of environmental assessment can be used for large land-use or construction projects (3c);
b) a concern that ecosystems are greatly affected by human activities (4a);
c) an appreciation that all ecosystems consist of complex interactions between biotic and abiotic factors.

Skills. Students will have the opportunity to develop skill in:

a) delineating a quadrat study area (2);
b) collecting samples of soil and leaves (2);
c) sweeping vegetation for arthropods (2);
d) counting the number of arthropods of a species (2);
e) recording abiotic factors, such as light intensity and humidity (2);
f) noting evidence of animals (2).

Knowledge. Students will be expected to:

a) list the types of organisms encountered in the field study (2);
b) describe how to choose and delineate a study area (2);
c) explain the methods of determining the various abiotic factors, such as temperature, light intensity, humidity, soil moisture levels, speed and direction of wind, pH and texture of soil, and levels of nitrogen, phosphorus, and potassium (2);
d) compare the abiotic and biotic factors in the different study areas (2);
e) describe interrelationships between abiotic and biotic factors in the areas being studied (2);
f) describe the influence of people on ecosystems.

2. Student Activities

*Students are to do a detailed environmental-impact study (analysis and assessment) of several different ecosystems, such as a wetland, a managed sodded area, an unmanaged open area, cropland, a shrub area, or a forest area, and assess the interrelationships of the various biotic and abiotic factors in each ecosystem (6a-6d, 8a-8e).

3. Applications

a) The techniques of environmental assessment can be used for any local area.
b) Analytical techniques can be used to assess the environmental impact of large construction projects.
c) Environmental-assessment techniques can predict the problems that will arise from monocultures.

4. Societal Implications

a) Many human activities, such as the construction of highways, the drainage of marshes, and urban development, have an extremely detrimental effect on natural ecosystems. There is a need for environmental-impact studies before such projects begin.
b) The solutions to the ecological problems of the future depend on the accurate collection, interpretation, and assessment of data.

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*See the subsection entitled "Student Activities" on page 5.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory and field work;
b) comparison charts and notes.

6. Safety Considerations

a) Students should be warned that they may encounter poisonous plants, such as poison ivy, on field trips.
b) Safety precautions, such as the use of the buddy system, should be taken when work groups are separated from one another, especially in wetlands.
c) All wild animals should be treated with caution.
d) The regional health authorities should be consulted to find out whether the wetlands to be studied harbour mosquitoes that are carriers of encephalitis.
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) extend the field study to include biotic factors (e.g., abundance, index species, bacteria) and abiotic factors (e.g., porosity and capillarity of the soil, organic matter in the soil);
b) discuss the adaptations of organisms to a particular environment;
c) do a field study of a new area.

8. Some Teaching Suggestions

a) Teachers should identify suitable study areas prior to beginning the unit. Each area should be examined to see whether any specific safety precautions will be necessary. The kind and size of quadrat to be used and the method of locating the quadrat should also be determined.
b) Permission to use the study sites should be obtained where this is necessary.
c) Equipment that will be required should be checked before the field trip.
d) When possible, organisms should be identified and counted at the site. It should not be necessary to take many samples back to the classroom.
e) Analysis techniques and the factors to be recorded should be explained fully to students and practised at the school before any area studies begin.
f) Some data collected in this unit can be stored and analysed on a computer.
g) The importance of not damaging the study areas should be stressed.

Optional Unit 3

Plant and Animal Pathology

Time: 15 hours

An organism becomes diseased when the complex and delicate balance that is normally maintained within it is disturbed. The disturbance may result from conditions in the physical, biological, or social environment; from hereditary causes; or from unknown causes. This unit will help students understand some of the best-known causes of disease and their impact on society.

This unit may be divided into topics such as the following:

- Infectious diseases
- Non-infectious diseases
- The transmission of disease
- Diseases of plants
- Diseases of animals
- Disease control

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a concern for the harm that diseases cause to society (4d);
b) an appreciation for the need to continue research into disease control;
c) an appreciation for the value and limitations of medicine in preventing and controlling disease (3d).

Skills. Students will have the opportunity to develop skill in:

a) identifying various diseases in plants and animals (2e);
b) estimating the potential for the transmission of disease (2g);
c) using aseptic techniques in the laboratory (2a, 2d, 2f).

Knowledge. Students will be expected to:

a) distinguish between infectious and non-infectious diseases;
b) describe the principal known causes of infectious and non-infectious diseases (2a, 2b);
c) name some substances in our environment that can cause disease;
d) explain several ways in which diseases are transmitted (2b, 2g);
e) explain the need for medicines;
f) name and describe some common diseases of plants and animals (2e);
g) describe some diseases that are infectious to humans and other animals;
h) explain the need for food-handling regulations (2d);
i) describe some methods of controlling disease (2f, 2h);
j) describe healthy ways of living that make people less susceptible to disease;
k) recognize that disease controls must be changed to combat new disease strains;
l) outline the role played by disease organisms in maintaining a balance in the ecosystem;
m) explain the role of food-spoilage organisms as decomposers in the ecosystem (2h).

2. Student Activities

Students are to:

*a) differentiate between bacterial cells as observed on prepared microscope slides;
b) draw a family tree to show the inheritance of disease in a family;
c) collect food labels, list the additives in various foods, and explain their purpose;
d) collect and test water samples for the presence of coliform bacteria (6a, 6b, 6d, 8c);
*e) collect samples of plant diseases, such as apple scab, peach canker, mildew, rust, and smut (6c, 6d, 8a, 8b);
f) compare the effectiveness of various antibiotics, antiseptics,and disinfectants on the growth of micro-organisms (6a, 6b, 6d, 8e, 8f);
*g) estimate the number of spores produced by one corn-smut growth (8a);
h) apply a food-spoilage organism to apples with damaged and undamaged skin and compare the amount of rot that develops (8a, 8b).

*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) Hygienic practices in restaurants help to halt the spread of communicable diseases.
b) A knowledge of plant and animal diseases is necessary for persons in agribusiness and wildlife management.
c) A knowledge of plant and animal diseases enables people to recognize diseases in their pets or gardens.
d) Compulsory immunization and the control of drugs, foods, and working environments by government agencies help to reduce disease.

4. Societal Implications

a) Drugs and vaccines intended to prevent or cure illness sometimes have adverse effects (e.g., thalidomide, chemotherapy).
b) Some bacteria that cause disease have become resistant to antibiotics, making them difficult to control.
c) Compulsory immunization of children has almost wiped out diseases such as smallpox and diphtheria.
d) A healthy population is more productive and less costly to maintain.

5. Evaluation of Student Achievement

At least 50 per cent of the evaluation for this unit is to be based on students':

a) laboratory work and reports;
b) science notes and comparison charts;
c) projects and assignments.

6. Safety Considerations

a) Students must use aseptic techniques when handling micro-organisms.
b) Cultures of micro-organisms must be destroyed before disposal.
c) Plants that students may be allergic to should be avoided.
d) Students should wash their hands after handling plants, animal parts, and chemicals.
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) test the effect of various growing media and moisture levels on the incidence of damping-off in snapdragon seedlings;
b) conduct a research project and report on the use of plants, animals, and micro-organisms in medicines;
c) test the effect of the pH of soil on the incidence of root rot in poinsettias;
d) visit a restaurant, cafeteria, or dairy to observe food-handling and sanitation practices.

8. Some Teaching Suggestions

a) Diseased plants can be collected in spring, summer, and fall and stored for future use.
b) The home garden may be a good source of plant diseases such as black spot on roses, mildew on grapes and lilacs, blight on tomatoes, and canker on peaches or plums.
c) Water samples can be sent to a nearby laboratory to be tested for coliform bacteria.
d) A local professional, such as a veterinarian, nurse, doctor, or research scientist, can be invited to speak to the class.
e) An expert in alternative medicine can be invited to speak about alternative treatments for diseases in humans and animals.
f) An expert in organic gardening or farming can be invited to speak to the class about alternative methods of controlling diseases in plants.

Optional Unit 4

Applied Genetics

Time: 15 hours

The application of the principles of genetics to the breeding of plants and animals has produced many important and practical advances in agriculture and related areas. The aim of applied genetics is to make plants and animals more efficient producers of the materials we usually obtain from them by making the fullest use of their desirable traits and counteracting their unfavourable ones.

This unit may be divided into topics such as the following:

- Environment and heredity
- The transfer of genetic information
- Plant and animal breeding

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the importance of breeding organisms to make them resistant to disease (4d);
b) an appreciation for the improvements in the quality of food that have resulted from applied genetics (3g, 4f);
c) an appreciation that mutations can be useful to society (2d);
d) an appreciation that new varieties of plants are not necessarily better than the older varieties (4e).

Skills. Students will have the opportunity to develop skill in:

a) calculating the probability of inheriting certain traits (2a);
b) interpreting data on the inheritance of traits (2a);
c) identifying abnormalities in organisms (2d, 2e);
d) observing the structure of cells under a microscope (2b).

Knowledge. Students will be expected to:

a) explain the roles of environment and heredity in changing organisms;
b) describe the contribution to genetics of some scientists (e.g., Mendel);
c) explain how genetic material is transferred and inherited;
d) explain why changes in organisms are necessary for the survival of the species and for the satisfaction of human demands;
e) define and discuss the value of the following: gene pool, mutation, hybrid, dominance (2a-2f);
f) give examples of characteristics that are inherited (2a, 2c, 2f);
g) describe some causes of infertility;
h) describe natural and artificial breeding techniques and their applications;
i) describe possible future applications of genetics.

2. Student Activities

Students are to:

*a) conduct a survey to determine the frequency of various traits in an organism and to establish concepts of dominance, recessiveness, no dominance, and frequency (8d);
*b) prepare slides of yeast cells to observe cell division, study slides of various cells and observe characteristics common to all cells, and observe chromosomes in cells in onion root tips or certain flies or maggots (8a, 8h);
c) collect and graph data to show variation in a species, such as length of oat seed and height of students (6a);
*d) grow plants from irradiated or chemically treated seed to show mutations (6a);
e) prepare slides of frozen semen and observe normal and abnormal cells (8f);
f) draw a family tree to show sex linkage (e.g., sex of chicks, colour blindness in humans) (8c);
g) treat tall and dwarf pea seedlings with gibberellic acid to investigate the differences in height (8e);
h) compare the ability of enzymes from round and wrinkled peas to change glucose to starch (8b).

3. Applications

a) A knowledge of pedigrees is useful in purchasing animals.
b) In order to breed animals for pets or for agriculture, it is necessary to understand the principles of genetics.
c) Through crossbreeding it has been possible to produce the hybrid poplar.

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*See the subsection entitled "Student Activities" on page 5.

d) Horses are bred for their size, speed, strength, and disposition, while fish are bred for their size, food value, and tolerance to warm water and pollution.
e) Breeds of dairy cattle that produce large amounts of milk have been developed.
f) By using seeds from the largest and most prolific plants of a species, farmers and plant breeders have been able to increase enormously the yield of their crops.
g) Through selective breeding, high-yielding strains of cereal grains have been developed.

4. Societal Implications

a) Some domestic animals are so highly bred that they have lost the ability to survive on their own (e.g., some domestic livestock could not survive in the wild).
b) The survival of some harmful insects through pesticide applications has resulted in an insect population that is immune to the pesticide.
c) Owing to the widespread adoption of new varieties of grains, some of the older varieties are in danger of becoming extinct and being lost from the gene pool.
d) Some high-yield varieties of grains have little resistance to some pests and require frequent applications of pesticides.
e) New varieties of fruit and vegetables have been bred for ease of mechanical harvesting, disease resistance, keeping qualities, appearance, and flavour. Sometimes one or more of these characteristics are somewhat sacrificed for other more necessary characteristics.
f) Through the selective breeding of plants and animals, scientists have been able to increase the supply of food and to feed a constantly growing population.
g) There is a limit to the ability of genetics to provide more and more food on less and less land.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit should be based on students':

a) laboratory exercises and reports;
b) projects, assignments, and notes.

6. Safety Considerations

a) Plant and animal materials that could cause allergies should be avoided.
b) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) study a specific organism, such as wheat, to see how heredity and environment have changed it;
b) compare the elasticity of flour in spring wheat, winter wheat, and triticale and determine why it is different;
c) research a new development in genetics;
d) grow plants such as petunias from seed collected in the home garden and investigate the characteristics of the seedlings (e.g., the colour of the flowers).

8. Some Teaching Suggestions

a) It should be stressed that a knowledge of mitosis and meiosis is essential to an understanding of genetics.
b) Students should avoid seeds treated with pesticides when collecting data.
c) Pedigrees can be used to hypothesize which mating systems were used to produce the offspring.
d) The practical applications of genetics should be stressed.
e) Gibberellic acid can be applied to pea seedlings approximately three weeks after germination.
f) Frozen semen can be obtained from a local breeder's unit.
g) Students might visit a research station, an artificial-insemination unit, or a farm.
h) The proper use of the microscope should be reviewed.

Optional Unit 5

Landscaping II

Time: 15 hours

The landscaping of a property, whether it be a private garden, a commercial front, a park, or factory grounds, requires careful and practical planning. The production of a master plan requires a knowledge of plant materials, construction materials, and the basic principles of design. This unit introduces students to the various aspects of making a plan and suggests a sequence for the steps in the implementation of the plan.

This unit may be divided into topics such as the following:

- Surveying and grading a property
- Constructed features
- Lawn construction
- Trees
- Foundation plantings
- Bed plantings
- Specimen plantings and hedges

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the combining of art and gardening skills in landscape design (3c);
b) a commitment to developing a plan before landscaping is attempted (3c);
c) an appreciation for examples of good landscape design when they are encountered (3a).

Skills. Students will have the opportunity to develop skill in:

a) inspecting a site for its advantages and problems (2a);
b) designing parts of a garden, such as a patio or foundation planting (2b, 2d);
c) sketching plants on basic property plans (2c, 2e);
d) planning a property, showing all permanent features and planting areas to scale (2e).

Knowledge. Students will be expected to:

a) explain briefly the necessity of establishing property lines and locating utilities;
b) explain briefly the effects of grading on surface drainage, ease of maintenance, and the control of sound, wind, and snow (2a);
c) compare the use of various construction materials;
d) describe practical considerations in designing walkways, driveways, patios, and other constructed features (2b);
e) describe the steps in preparing an area for grass, including seeding and sodding;
f) list the criteria for choosing plants, including plant requirements, effects on environmental conditions, and suitability to the design;
g) list the types of plants commonly used in bed plantings, such as shrubs, trees, evergreens, ground covers, annuals, and perennials;
h) list uses of specimen plantings and hedges;
i) discuss the effects of the size of a property and buildings on the size of the plants used for landscaping;
j) describe the steps in planting various types of plants;
k) discuss problem areas, such as wide roof overhangs, narrow foundation planting beds, soil erosion, poor soil quality and depth, soil settling, and soil dryness by foundation walls, and indicate how they are overcome.

2. Student Activities

Students are to:

*a) inspect various sites, noting grading, services, maintenance problems, and construction features (6a, 8a);
*b) design a permanent outdoor feature, such as a driveway, walkway, patio area, or pool area, and show its relationship to the rest of the property (8a-8e);
*c) sketch suitable placements for trees, hedges, conifers, and flower beds on a prepared property plan;
d) design a large shrub bed (8d, 8e);
*e) design a plan for a property, showing all permanent features and planting areas to scale and suggesting suitable plant materials (8d, 8e).

*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) The value of a house is increased by attractive landscaping.
b) The location of plants can affect the garden microclimate.
c) A knowledge of the steps in good landscape planning can be used to improve a home lawn or garden.

4. Societal Implications

a) Many parks and public spaces in cities could be made more attractive and comfortable by good landscape design.
b) Commercial and industrial sites can be improved in appearance by good landscape planning.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) planning assignments and sketches;
b) science notes.

6. Safety Considerations

a) Students should be warned about possible allergies to the plants that are being examined.
b) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

7. Possible Extensions

Some students might:

a) design a foundation planting for a house, indicating the plants that will be used;
b) practise sketching and planning related to a landscaping project;
c) name suitable plants for various sketches or plans submitted;
d) calculate the cost, including plants, labour, and material, for an area to be landscaped.

8. Some Teaching Suggestions

a) Visual examples of the principles of landscape design are essential. Coloured slides or overhead projectuals or visits to actual sites should be encouraged.
b) The topics of this unit, if taken in order, follow the development of an actual site. It should be emphasized that, if the steps are followed in this order, materials and labour can be saved.
c) The need to conserve the topsoil from the driveway and the site of the house should be stressed.
d) The landscape plan should be the main project for this unit. As far as possible it should incorporate the various principles and concepts presented in the unit. Large paper is recommended for the plan.
e) Old nursery catalogues are good sources of information about suitable plants.

Optional Unit 6

Agribusiness

Time: 15 hours

Agriculture and farming, like other large businesses, demand careful decisions about the organization of the operation. Decisions must be made about what to produce, how much to produce, the kinds and amounts of plant and animal resources to use, what kind of technology to use, when and where to buy and sell, and how to finance the operation. This unit will give students background knowledge for making those decisions.

This unit may be divided into topics such as the following:

- Agricultural production and facilities
- Basic economic principles as they apply to agriculture
- Budgeting for a farm operation
- Farming as a business
- Management skills
- Sources of agricultural services and information

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation that management decisions have an influence on employment, interest rates, and food prices (3a);
b) a respect for agriculture and farming ventures as businesses (3a, 3d);
c) a concern for safety as an important part of farming (3c).

Skills. Students will have the opportunity to develop skill in:

a) establishing a budget for a farm operation (2d, 2e);
b) locating sources of agricultural information and services (2g);
c) making decisions and solving problems in a food-production business (2c-2e).

Knowledge. Students will be expected to:

a) describe agricultural production and facilities in a particular area (2a, 2b);
b) state the law of supply and demand, the law of diminishing returns, and the theory of price cycles (2c);
c) describe the basic concepts of budgeting (2d);
d) describe the qualities necessary for running a business, including the ability to make decisions, a positive attitude, and the ability to work with people (2e, 2f);
e) compare the business of agriculture to other local businesses;
f) explain safety practices on the farm;
g) list some of the sources of agricultural services and information, including the Ontario Ministry of Agriculture and Food, Agriculture Canada, farm magazines, Statistics Canada, and farm-market reports (2g);
h) compare local agricultural productivity to that for Canada as a whole (2b);
i) list the qualities of a successful farm manager.

2. Student Activities

Students are to:

a) survey class members to identify agricultural production facilities used by their families;
b) investigate which processing operations for agricultural products exist in a particular area (8a, 8c);
*c) analyse agricultural case studies that demonstrate basic economic principles (8d);
*d) develop a budget for an imaginary farm operation specializing in beef, dairy, or cash crops and analyse the budget with the class (8d);
*e) compare a farm business to a different local business and discuss factors of production, costs, risks, and specialization (8a, 8c, 8e);
f) role-play a farmer and hired labour in a farm business situation;
*g) conduct a research project to identify sources of agricultural information and services (8c).

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*See the subsection entitled "Student Activities" on page 5.

3. Applications

a) Good business practices can improve a farmer's relations with his/her employees and make the farm enterprise more successful.
b) Local sources of information can help a farmer make wise decisions.
c) A knowledge of safety may reduce the number of farm accidents.
d) An understanding of economics as it applies to agriculture may lead to more efficient agricultural production and higher profit margins for farmers.

4. Societal Implication

An appreciation and understanding of Canadian agriculture may encourage people to buy Canadian agricultural products and thereby lead to a reduction in agricultural imports.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) budgets for a farm operation;
b) projects.

6. Safety Considerations

The nature of this unit is such that there are no specific safety considerations.

7. Possible Extensions

Some students might:

a) analyse their own family's farm operation as a case study;
b) analyse the reasons for bankruptcies and successes among farm operators;
c) compare Canadian agriculture with agriculture in a European country or a developing country;
d) investigate the changes in the farm business over the last two generations.

8. Some Teaching Suggestions

a) An agricultural representative can be invited to speak to the class about agricultural production and businesses in the county or local area.
b) The importance of safety in the farm business should be emphasized. Arrangements should be made for students to see films and demonstrations of safety on the farm.
c) Government agencies, machinery dealers, and feed processors in the local community can provide resources such as films, printed material, and speakers.
d) The fact that decisions on the farm must be based on up-to-date information should be stressed.
e) A work-experience program or co-operative education program in agriculture can be established.

Optional Units 7 and 8

Locally Designed Units

Time: 15 hours each

Two locally designed units are to be developed for this course. These two units are the same for the Grade 12 environmental science course as optional unit 6, "Locally Designed Unit", is for the Grade 10 course (see page 30). A different set of topics from those selected for Grade 10 or 11 should, of course, be chosen for this course.

Appendixes

Appendixes

A. Science Courses and Their Course Codes

B. The Table of Contents of Part 1

Appendix A

Science Courses and Their Course Codes

The secondary school guideline courses in science authorized under this document have the following course codes:

Science, Grade 9, Basic Level	SNC1B
Science, Grade 9, General Level	SNC1G
Science, Grade 9, Advanced Level	SNC1A

Science, Grade 10, Basic Level	SNC2B
Environmental Science, Grade 10, General Level	SEN2G
Science, Grade 10, General Level	SNC2G
Environmental Science, Grade 10, Advanced Level	SEN2A
Science, Grade 10, Advanced Level	SNC2A

Science, Grade 11, Basic Level	SNC3B
Applied Biology, Grade 11, General Level	SBA3G
Applied Chemistry, Grade 11, General Level	SCA3G
Environmental Science, Grade 11, General Level	SEN3G
Biology, Grade 11, Advanced Level	SBI3A
Chemistry, Grade 11, Advanced Level	SCH3A

Science, Grade 12, Basic Level	SNC4B
Environmental Science, Grade 12, General Level	SEN4G
Geology, Grade 12, General Level	SGE4G
Applied Physics, Grade 12, General Level	SPA4G
Environmental Science, Grade 12, Advanced Level	SEN4A
Geology, Grade 12, Advanced Level	SGE4A
Physics, Grade 12, Advanced Level	SPH4A
Technological Science, Grade 12, General Level	STE4G

Biology, OAC	SBI0A
Chemistry, OAC	SCH0A
Physics, OAC	SPH0A
Science in Society, OAC	SSO0A

The following general rules govern science course codes:

- All science course codes begin with an **S**.
- **SNC** identifies a course that has only the name "Science".
- Where one word other than "Science" describes the course, the first two letters of that word follow the **S** (e.g., **SBI** means "Science, Biology" or simply "Biology"; **SEN** means "Science, Environmental" or "Environmental Science").
- Where two words other than "Science" describe the course, the initial letters of those words are used (e.g., **SCA** means "Science, Chemistry Applied" or simply "Applied Chemistry").
- The fourth character in the course code, **1**, **2**, **3**, **4**, or **0**, represents Grade 9, 10, 11, 12, or an OAC respectively.
- The fifth character represents the level of difficulty: **B** for basic, **G** for general, or **A** for advanced.

For further information on course codes, refer to the *Manual for the Common Course Code* (Toronto: Ministry of Education, Ontario, 1986).

Appendix B

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Appendixes

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